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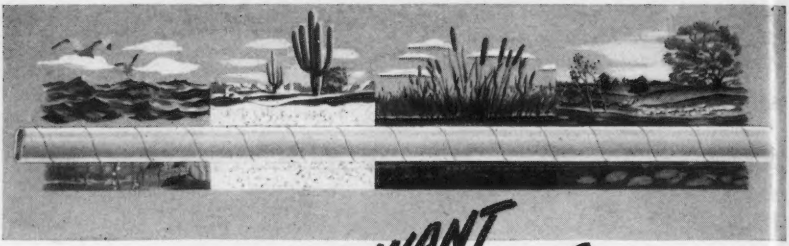

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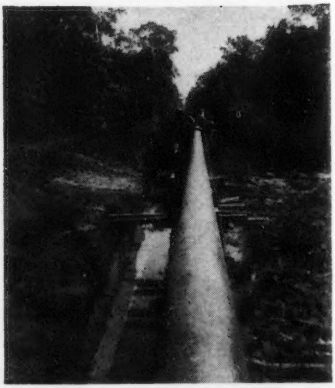

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• *Conducting an impact test with a special machine to determine resistance of a specific protective coating. See page 112.*

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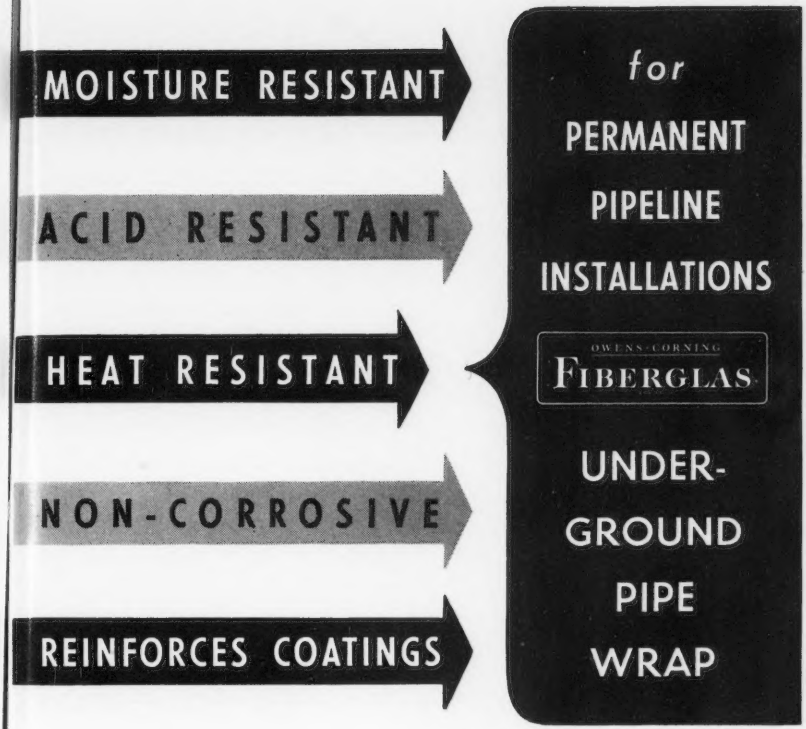

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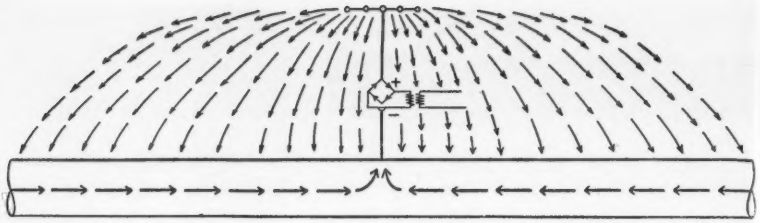

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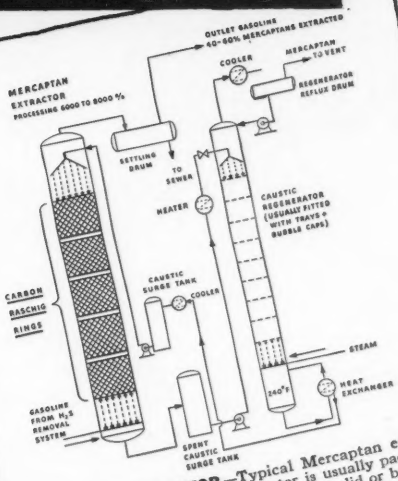

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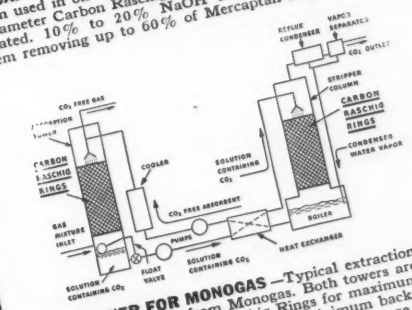

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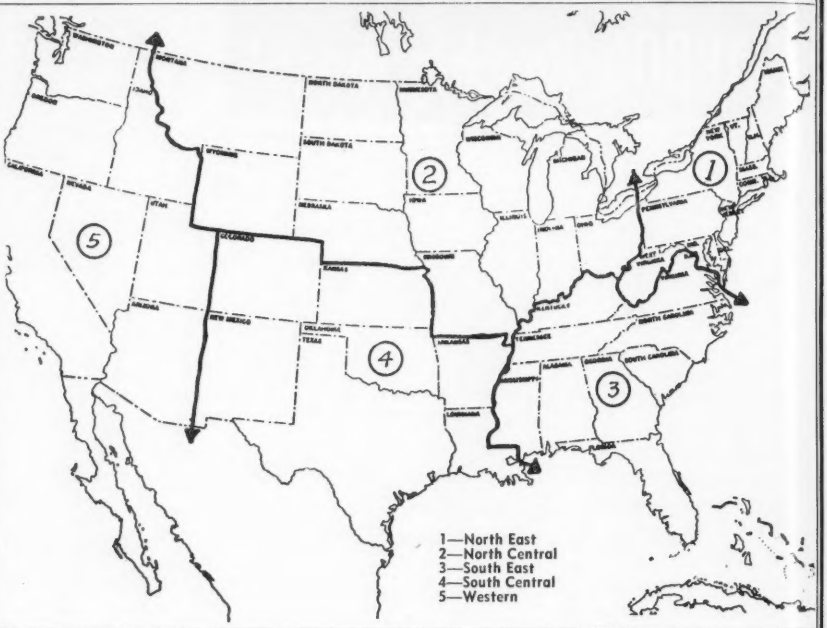

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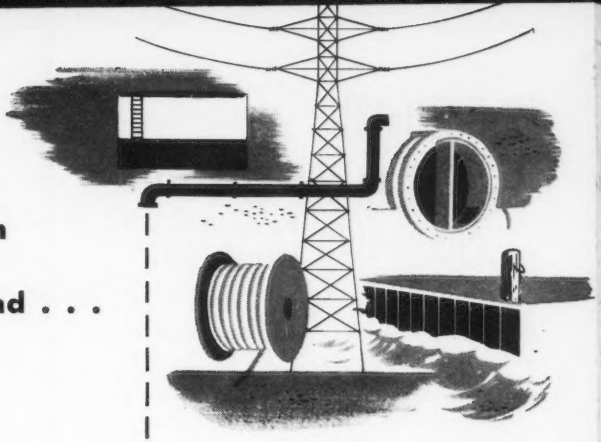

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(b) to provide a means of exchange of knowledge and ideas among those individuals actively engaged in the control of corrosion.

(c) to promote methods of control of corrosion.

(d) to promote standardization of terminology, methods, equipment and design in the development of methods of corrosion control.

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Salt as a Medium of Corrosion Of Underground Cables*

*By A. G. Andrews**

IN AREAS where grounded d-c electric railways are operated, some of the return current strays from the rails to underground metallic structures, such as lead covered telephone cables. These parallel structures provide low resistance paths for the current to return toward its source of supply, near which point it leaves the cables. This interchange of current from one grounded structure to another presents serious anodic corrosion problems.

For many years protection from this type of corrosion has been provided by electrolysis drains, which consist of low resistance copper conductors connecting cables to the negative return of the railyway system. This method of protection, where several structures are drained to a common point, has a disadvantage in that various structures have different potential gradients, which result in differences of potential between the various structures at points remote from the substation.

Figure 1 illustrates a typical case, where a potential difference exists between rail and telephone cables. The voltage drop measurements shown in the figure were made by using telephone cable pairs. A difference of potential of five volts between rail and cable was measured at Cedarhurst and Woodward avenues. This corresponds to the difference between the voltage drop over the rail return of ten volts and that over the telephone underground cables of five volts.

At one time it was believed that cables, maintained at a negative potential with respect to other structures, were immune from corrosion. When cable corrosion failures were experienced at locations which were continuously negative, investigation of the corroded cables and their environments disclosed a strong alkali concentration. In some cases, a white slimy substance, slippery to the touch and irritating to the skin, was found packed around cables in the duct. These conditions usually develop at locations adjacent to rail switches treated with salt to prevent freezing in winter. Earth surrounding these switches became saturated, causing a reduction of the earth's resistance and resulting in an increase of stray current from the rails. It was determined that the action of the stray current on salt, as shown in Figure 2, caused sodium

★ A paper presented at the Annual Meeting of NACE in Chicago, Ill., April 7-10, 1947.

* Cable Testing Supervisor, Michigan Bell Telephone Company, Detroit, Mich.

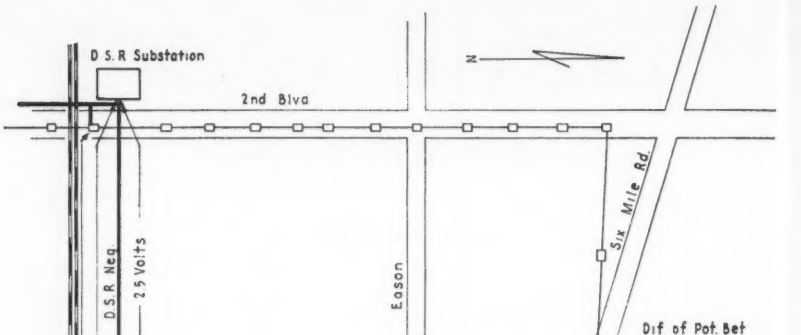


Figure 1—Voltage drops over telephone cables and rail system.

hydroxide (NaOH) to be formed at the cables within the ducts, resulting in corrosion of lead cables from chemical attack. This electrochemical action is shown in Figure 3. The sketch shows a cell containing two electrodes submerged in a salt solution and connected to an external source of electric current. Dissolving salt (NaCl) in water causes it to become ionized into positively charged sodium ions and negatively charged chloride ions. When current flows from the anode to the cathode through the electrolyte, the ions migrate. Sodium ions are attracted to the cathode, where they lose their charge by gaining electrons, to become atoms. The sodium atoms react with water to form sodium hydroxide and hydrogen gas. The negative chloride ions are attracted to the anode, where they lose their charge by losing electrons, to become atoms and chlorine molecules, which escape as chlorine gas.

The formation of sodium hydroxide by this electrochemical action can be demonstrated by adding a small amount of phenolphthalein to the cell just described. The flow of current will cause a red color to form at the cathode, indicating formation of alkali. As the current continues to flow, the red color increases in density and volume.

When cables and rail switch are close together it can be assumed that the earth between the two structures is saturated with salt. However, if the two structures are separated by a considerable distance there may be a question as to the salt saturation of the intervening earth. It can be demonstrated that the migration of the sodium ion con-

tinues regardless of the salt saturation of the current's path.

The same electrochemical action which takes place between rails and cables in metropolitan areas is made use of commercially, with specially designed alkaline chlorine cells, to produce sodium hydroxide and chlorine gas.

Solubility of sodium hydroxide in water provides a means of removing the corrosive chemical from the conduit system by flushing with water.

To proceed with the flushing project, it is first necessary to segregate the section of conduit containing alkaline salt, as shown in Figure 4. This is accomplished by plugging ducts through which the water is not to flow in the manholes at both ends of the section or sections to be flushed. Wooden or rubber plugs are used in vacant ducts and oakum in those occupied by cables. All cables to be submerged are filled with dry nitrogen gas at a pressure of nine pounds per square inch. One of the manholes in the segregated portion, usually determined by the grade of the street's surface and the location of the fire hydrant, is then filled with water by means of a hose connected to the hydrant. Water is allowed to flow through the ducts to the manhole at the far end of the section or, as in the case illustrated by the figure, where water is applied at the center manhole and allowed to flow in two different directions, flushing two sections simultaneously. At the far ends of the sections, water is drained off through sewer connections in the manhole, or pumped out. Samples of the flushing water at the end manholes are tested frequently with phenolphthalein. The red color obtained by the test indicates the presence of the alkali and also the progress of its removal by the flushing procedure.

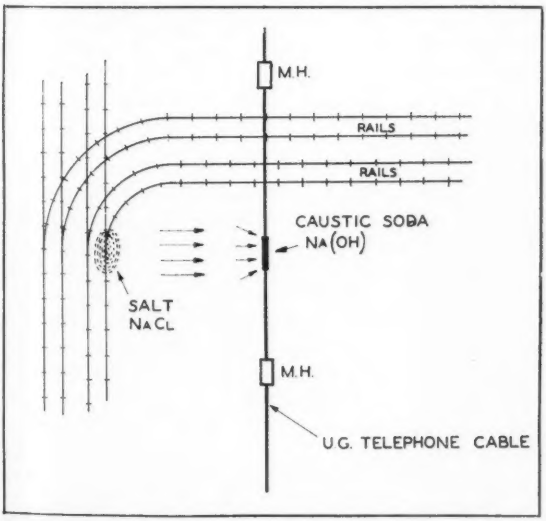


Figure 2—Formation of caustic soda by action of stray current on salt deposited on rail switch.

Approximate measurement of the alkaline content of conduit is desirable for purpose of comparing the accumulation of the alkali for different periods of time, or for comparing one location with another. This measurement is accomplished by taking a sample of the flushing water from the ducts at the far manhole. Fifty cc of this water are treated with phenolphthalein and then titrated with

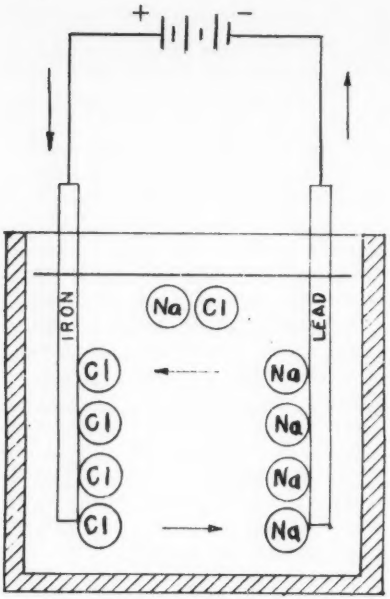


Figure 3—Electrochemical cell.

one-tenth normal hydrochloric acid to the point of neutralization. The ratio of the number of cc of acid required, to the 50 cc of solution, is considered as the measurement of the alkali present. This is not an attempt at quantitative analysis but rather a simple and convenient yard stick measurement for comparison purpose. The duct flushing project has been conducted in Detroit for the past 13 years with satisfactory results, as shown by the curve in Figure 5.

Cathodic action does not always result in corrosion. Many times white, salty appearing substances have been found precipitated on manhole walls and cables, as shown in Figure 6. In some cases, tests have shown the substance to be a stalactite or stalagmite formation of calcium carbonate. It is not always possible to determine corrosive qualities of a deposit from visual inspection, as they are often similar in appearance. A chemical test is relied on to tell the story. The test consists of dissolving a sample of the deposit or scale in dilute nitric acid. Any lead compound contained in the substance is thereby brought into solution, which is divided into two separate portions. To the first portion dilute hydrochloric acid is added. If lead is present, a white

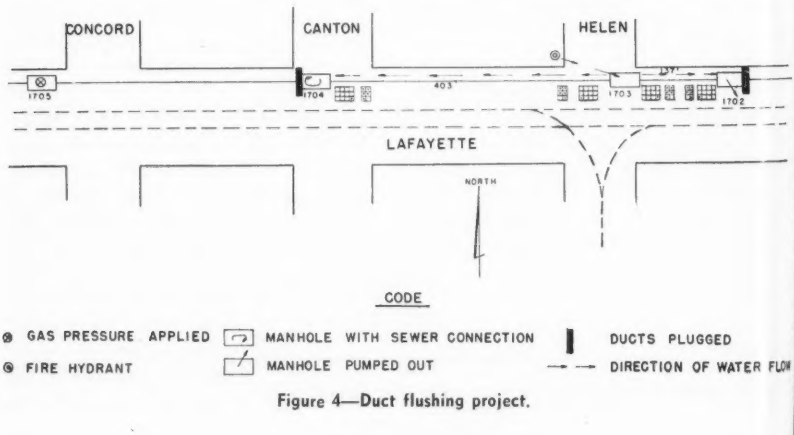
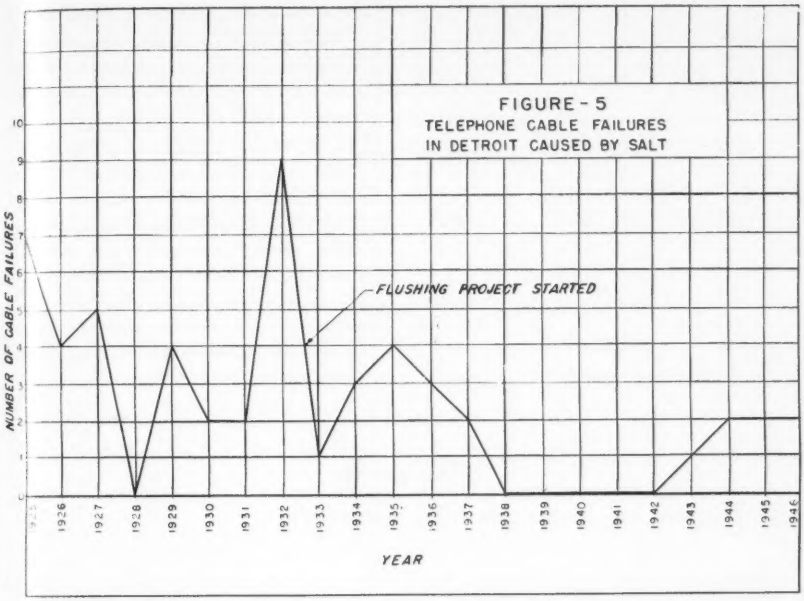


Figure 4—Duct flushing project.



precipitate of lead chloride will be formed. To confirm this test, a small amount of potassium chromate is added to the second portion. A bright yellow precipitate of lead chromate will indicate the presence of lead.

If both portions of the solution remain clear upon adding the two reagents, it is an indication that no lead compound is present and apparently the substance tested did not result from corrosion of the lead cables. If the presence of lead is shown by the test, it is an indication that the substance is in part the result of corrosion of the lead cables, and protective measures should be considered.

Measurements of potential relations between cables and other underground structures have provided a means of predetermining anodic corrosion danger spots, thus making it possible to apply protective measures and prevent likely cable failures. Cathodic corrosion presents a

Figure 6—Electrolytic deposit on telephone cables.

new problem, because reliable predetermination of failure locations are not possible. Usually, the barn is locked after the horse has been stolen; that is, protective measures are applied after the failure has occurred. In an effort to improve on this procedure an attempt was made to locate and remove this corrosive alkali before any damage was caused.

The knowledge that failures usually occur adjacent to rail switches covered with salt provides a clue. All salt-covered switches on heavily loaded rail lines which paralleled cable runs were spotted. From available manholes at such locations a steel fish tape, having a wad of cloth fastened to the end, was pushed up a vacant duct to a point opposite a rail switch. The tape was then removed and the cloth treated with phenolphthalein. If the wad of cloth turned red, it indicated the presence of alkali and the location was marked for flushing with water. This procedure has satisfactorily located a number of possible danger spots and the alkali removed before damage resulted.

Discussion

*By T. W. Alexander**

So-called cathodic or negative corrosion of underground lead-covered cable, as covered in Mr. Andrews' article, also has been experienced in Pittsburgh for a number of years. About 1934, it was first recognized that cable failures attributable to something other than the usual anodic or positive corrosion was being experienced, and steps were taken to find the cause.

Before becoming aware of this unknown, a great deal of time, effort and money were expended correcting conditions where cables were positive to earth; and because of this activity, anodic failures had decreased noticeably. Then, we began to have failures where cables had been maintained negative to earth, and had been negative a number of years.

Chemical analyses of soil at these trouble locations indicated the presence of sodium chloride or common table salt; and in each case, the source was traced to the use of salt for snow and ice removal. Most cases were at street railway switches, or stretches of track which had been salted and a few were traceable to the use of salt on pavements and to locations where ice cream trucks had dropped salt solutions in the street.

Corrosion-protected cable and flushing of the underground duct system with water have been the methods used to combat this type of corrosion.

Corrosion-protected cable has two reversed layers of Sisalkraft paper over the lead sheath and an outer layer of rubber-filled tape. The sheath and each layer of protective material are flooded with an asphalt compound. A coating of non-adhes-

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ive material is applied to the finished cable to prevent sticking of adjacent turns on the reel. The protective covering increases the diameter of the cable about 0.2 inch.

Though cable protected as described is moisture-resistant, it will not keep out moisture indefinitely, and its value over a long period of time as a means of combating cathodic corrosion is unknown. It has been used in our territory about eight years, and there has not been a failure during this time. In contrast to this performance of corrosion-proof cable, we have lost plain lead sheath cables attributable to cathodic corrosion in two years, to cite an extreme case; and in others, five years. Protective cable will therefore delay corrosive action, but for what period of time is not yet known.

All sections of cable which fail because of cathodic corrosion are replaced with corrosion-protected cable. Also, all new cables installed in sections where this type of corrosion has been experienced are of the corrosion-protected type.

Adopt Detroit Flushing System

Flushing of the duct system was first tried by directing a stream of water from a fire hose into the ducts at a manhole. This method was not successful because the joints in the duct system are not watertight and the water was dissipated near the end of the ducts where it was being applied and did not pass through to the next manhole. Meanwhile, use of salt for snow and ice removal increased, and more cables were lost in these areas.

We were then advised of the flushing method which was being used in Detroit; that is, by plugging the ducts and filling the manhole with water, and in 1943, a duct flushing program was started using that method. During that year we flushed 52 sections of conduit, a section being all the ducts between successive manholes. In 1944, only nine sections were flushed; in 1945, 46 sections; and in 1946, 80 sections. All of these are not new sections.

Flushing a Continuous Process

Sections are flushed repeatedly, year after year, if they continue to show signs of alkalinity, as most of them do even after repeated flushing. The addition of salt each winter, of course, replenishes the alkaline material in the soil.

The original flushing may continue for several hours until the water at the discharge end of the ducts shows no sign of alkalinity with the phenolphthalein test. This same section is then flushed on succeeding days until the first water from the discharge end of the ducts shows no sign of alkalinity. These succeeding flushings usually require a shorter period of time than the original one to give a satisfactory test. However, in extreme cases, the flushing records show that it is often necessary to flush for an hour or more on succeeding flushings to obtain a test showing no alkalinity. In other cases, only a few minutes are required.

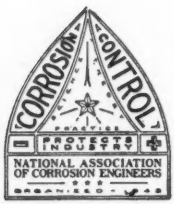
Cost of flushing operations has varied considerably because of various procedures used. It is estimated that the cost of flushing 80 sections, as we did in 1946, would be paid for by the elimination of one major

cable failure. Furthermore, a cable failure causes service interruptions to a large number of customers and any reasonable expense which will pervent this is well worthwhile.

Indications are that the use of salt for ice removal is increasing. Several municipalities in the area surrounding Pittsburgh are investigating its value for this purpose and it is expected that troubles from this source will increase. It is claimed by those who favor the use of salt, that it is as cheap to use as cinders and does not have the disadvantage of clogging sewers.

Use of salt for this purpose should be of concern not only to telephone companies, but to all companies who have underground metallic structures. Indeed, it should be of concern to every automobile, truck, and bus owner because of the effect of salt solutions splashed on the undercarriage of these vehicles. It is hoped that eventually there may be enough reaction from these sources to cause careful consideration to be given to this problem.

In the meantime, it is expected that we will continue to flush those sections of underground conduit where trouble has been experienced and that this may also be extended in some cases to those sections where trouble is anticipated.



Corrosion Tests in Sulfuric Acid In Petroleum Refinery Processes

*By W. Z. Friend**

FOR A GOOD MANY years refineries have been contending with the problem of corrosion by sulfuric acid in the acid treatment of petroleum products. In recent years, the problem has been enlarged by the adoption of hydrocarbon polymerization and extraction processes which, in some cases, involve the handling of sulfuric acid solutions under more corrosive conditions than are usually encountered in regular treating processes. These sulfuric acid processes include the polymerization of olefins, as in the production of isooctenes from isobutenes; the production of alcohols, such as ethanol, isopropanol, and tert-butanol from refinery gases, and catalytic alkylation processes, such as the synthesis of isooctane from butene and isobutane. In some processes, initial reactions are carried out with high sulfuric acid concentrations at relatively low temperatures, and with the acid dispersed in the hydrocarbons, so that corrosion is only moderate; and carbon steel often can be used. However, where water is added to the reacted mixture to accomplish regeneration, recovery and separation of the acid, acid concentrations are low enough and temperatures high enough for severely corrosive conditions to exist. In the evaporation of dilute acid mixtures to recover concentrated acid, corrosion is so severe that only a few metallic materials are suitably resistant.

Taken as a whole, these processes involve the handling of sulfuric acid under practically all possible conditions of temperature and concentration, and require the use of a wide variety of metals and alloys for construction of plant equipment. The problem of selection of the most suitable and economical material for a particular application is complicated by the fact that conditions of concentration, temperature, velocity, aeration, and other factors, in acid recovery processes may vary considerably among refineries, making it difficult to apply experience at one plant directly to a somewhat similar process at another. Usually it is necessary to make corrosion tests or service tests under actual operating conditions at each plant, to be sure that a proper selection is made.

The purpose of this article is to present results of a number of plant corrosion tests and of several lab-

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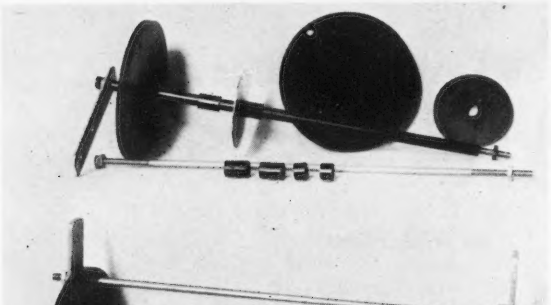

Figure 1—Spool-type specimen holder used in testing corrosion of metals.

oratory corrosion tests under conditions representative of some of the sulfuric acid applications encountered in refineries. Probably the best use which can be made of this information is that it may serve as a guide to materials most worthy of further investigation.

Corrosion tests reported here were made with the spool-type specimen holder illustrated in Figure 1. This method of testing is substantially in accord with ASTM Recommended Practice for Conducting Plant Corrosion Tests, A224-41.[1] Briefly, the assembly consists of previously cleaned and weighed specimens of the several metals and alloys to be tested, mounted on the spool-type holder, with non-metallic parts of porcelain or bakelite to separate and insulate the specimens from each other and from the metallic parts of the holder. Two similar specimens of each material were included on each spool. The completed test assemblies were fastened firmly in place in the desired test locations in operating plant equipment and allowed to remain for sufficient lengths of time to give reliable indications of corrosion behavior. Each test specimen had an exposed area of 0.5 square decimeter.

Upon completion of tests, test spools were removed, dismantled, and specimens examined, cleaned of all scale and corrosion product, and reweighed. From the weight losses, areas of specimens and duration of exposure, the corrosion rates were calculated in terms of milligrams per square decimeter per day, and these rates transposed to inch penetration per year (ipy), the unit used in the tables accompanying this article. This unit is based upon the assumption of uniform corrosion in

TABLE I

Nominal Compositions of Metals and Alloys Used in Corrosion Tests

METAL OR ALLOY	Nickel Percent	Copper Percent	Chromium Percent	Iron Percent	Molybdenum Percent	Silicon Percent	Manganese Percent	Carbon Percent	Other Percent
Monel	67.0	30.0	....	1.4	....	0.1	1.0	0.15	....
"K" Monel	66.0	30.0	....	0.9	....	0.5	0.85	0.15	Al. 2.75
"S" Monel	63.0	30.0	....	2.0	....	4.0	0.75	0.1	....
Nickel	99.4	0.1	....	0.15	....	0.05	0.2	0.05	....
Inconel	78.5	0.2	14.0	6.5	....	0.25	0.25	0.08	....
70-30 Copper-Nickel	30.0	70.0	....	....	....	....	....	....	....
Copper	....	99.9+	....	....	....	....	....	....	....
Bronze (85-5-5-5)	....	85.0	....	....	....	....	....	....	Pb. 5.0; Sn. 5.0; Zn. 5.0
Aluminum Bronze (10 percent Al.)	....	88.0	....	2.0	....	....	....	....	Al. 1.0
Aluminum Bronze (13 percent Al.)	....	83.0	....	4.0	....	....	....	....	Al. 13.0
Silicon Bronze	....	96.0	....	....	....	3.0	1.0	....	....
Hastelloy A	57.0	....	....	20.0	20.0	1.0	2.0	0.1	....
Hastelloy B	62.0	....	....	6.0	30.0	1.0	1.0	0.1	....
Hastelloy C	55.0	....	15.0	6.0	17.0	1.0	1.0	0.1	W 5.0
Hastelloy D	85.0	3.0	....	....	....	10.0	1.0	....	Al. 1.0
Illium R	60.0	3.0	21.0	8.0	5.0	0.6	1.25	0.1	W 1.0
Illium G	58.0	6.0	22.0	6.0	6.0	0.6	1.25	0.2	....
Durimet L	22.0	0.4	20.0	Bal.	....	3.0	....	0.07	....
Durimet T	22.0	1.0	20.0	Bal.	3.0	1.0	....	0.07	....
Durimet 20	29.0	4.0	20.0	Bal.	3.0	1.0	....	0.07	....
Alloyco 20	29.0	4.0	20.0	Bal.	3.0	1.0	....	0.07	....
Worthite	24.0	2.0	20.0	Bal.	3.0	3.0	....	0.07	....
Pioneer Metal	35.0	....	25.0	Bal.	5.0	....	....	0.1	....
18-8 Stainless: (Type 302)	9.0	....	19.0	Bal.	....	....	1.2	0.20 max.	....
(Type 304)	9.0	....	19.0	Bal.	....	....	1.2	0.08 max.	....
18-8 Mo Stainless: (Type 316)	13.0	....	18.0	Bal.	2.25	....	1.5	0.08 max.	....
(Type 317)	13.0	....	18.0	Bal.	3.25	....	1.5	0.08 max.	....
25-20 Stainless: (Type 310)	20.0	....	25.0	Bal.	....	....	1.5	0.20 max.	....
80-20 Nickel-Chromium	80.0	....	20.0	Bal.	....	....	....	....	....
61-15 Nickel-Chromium-Iron	61.0	....	15.0	Bal.	....	1.3	....	....	....
Chemical Lead	....	....	....	....	....	....	....	....	Pb. 99.9
Duriron	....	....	....	Bal.	....	14.5	....	....	....
Corrosion	....	....	....	Bal.	....	14.5	....	....	....
Ni-Resist (Type 1)	14.5	6.0	2.0	Bal.	....	1.8	1.3	2.8	....
Mild Steel	....	....	....	Bal.	....	0.25	0.45	0.2	....
Cast Iron	....	....	....	Bal.	....	1.8	0.5	3 4	....

practice from one side of the metal only. The rate shown for each material is the average of the two specimens included in each test. In addition, each specimen was examined for cracking, pitting, and other forms of local attack. Where pitting or local attack occurred, depth of the five or ten deepest pits was measured microscopically or with a depth gauge. In the tables included, maximum depth of pitting is reported, where it occurred.

Nominal compositions of the metals and alloys included in one or more of these tests are shown in Table I.

Acid Treatment of Distillates

Acid treatment of lubricating oils and other distillates usually is done with successive additions of sulfuric acid of 66°Be or higher strength. The amount of acid used may vary from 5 to 25 or more percent by weight of the charge, depending upon the source and viscosity of the distillate. Temperatures usually range from atmospheric to 150° F., but may go as high as 220° F. Mixing is accomplished by a variety of

TABLE II

Plant Corrosion Tests in Sulfuric Acid Treatment of Petroleum Products

Test 1. Immersed in treating tank during agitation of acid with crude oil. Mechanical agitation. Temperature, atmospheric. Duration of test 92 days.

Test 2. Immersed in acid sludge containing 25 percent sulfuric acid in six inch discharge line from acid treater. Average temperature 140° F. Duration of test 55 days. Mechanical agitation.

Test 3. Immersed above draw-off nozzle of lube oil acid-treater. After mixing and dilution of acid, the lube oil mixture contains 2 percent sulfuric acid, 40 percent water, and 58 percent hydrocarbons. Temperature 90-150° F. Duration of test 15 days. Mechanical agitation.

Test 4. Immersed in lube oil acid-treating tank. Acid content of mixture 25 percent sulfuric acid. Temperature up to 220° F. Duration of test 10 days. Mechanical agitation.

Test 5. Immersed three feet above bottom of cone in fuel oil treating tank during treatment with four pounds per barrel of 66° Be acid followed by water washing and treatment with 10° Be caustic soda. Agitated with air. Temperature 80-105° F. Duration of test 56 days.

MATERIAL	Corrosion Rate, Inch Penetration Per Year				
	Test 1	Test 2	Test 3	Test 4	Test 5
Monel	0.0003	0.006	0.003	0.003	0.018
"K" Monel	.....	.....	0.003	.....	.....
"S" Monel	.....	.....	0.006	.....	.....
Nickel	0.0008	.....	0.013	0.011	0.037
Inconel	.....	0.015	0.014	0.016a	0.016
70-30 Copper-Nickel	0.0002	.....	.....	0.005	.....
18-8 Stainless (Type 302)	.....	.....	0.019	y	0.018b
18-8 Stainless (Type 304)	.....	.....	0.019	y	.....
18-8 Mo Stainless (Type 316)	.....	0.008	0.006	y	0.018c
Durimet L	0.0009	.....	.....	.....	.....
Worthite	.....	0.003	0.004	.....	0.012
Hastelloy A	.....	.....	.....	.....	0.003
Hastelloy B	.....	0.009	.....	.....	.....
Hastelloy C	.....	0.002	.....	.....	.....
Hastelloy D	.....	.....	0.009	.....	.....
Illium G	.....	0.003	.....	.....	.....
Aluminum Bronze (10 percent Al.)	.....	0.005	.....	.....	.....
Chemical Lead	.....	.....	.....	0.025	0.038
Ni-Resist (Type 1)	0.003	0.008	0.021	.....	0.036
Cast Iron	0.044	x	0.16	.....	0.056
Mild Steel	0.007	.....	0.090	.....	0.021

x Specimens corroded entirely away. Original thickness 3/16 inch.
y Specimens corroded entirely away. Original thickness 0.031 inch.
a Pitted to maximum depth of 0.010 inch.
b Pitted to maximum depth of 0.008 inch.
c Pitted to maximum depth of 0.005 inch.

means, including mechanical agitators, circulating pumps, contacting towers, or by special devices such as mixing nozzles. In some cases, air agitation may be used. The acid picks up some water from the oil and usually must be further diluted with water to accomplish good separation of the acid sludge after treatment, so that water solutions of acid concentration down to 5 or 10 percent may be encountered in the separation systems.

In batch operations it is frequent practice to do mixing, settling, water washing, and sometimes caustic neutralization in the same vessel. In continuous systems and in some batch systems, these various steps may be accomplished in separate vessels.

In Table II are given the results of plant corrosion tests in batch vessels where acid treatment and some water dilution were carried out in the same vessels. These tests were made in five different plants under a variety of conditions of acid concentration, temperature and agitation. During the mixing of concentrated acid and oil, corrosion is usually not severe at moderate tem-

peratures due to the dispersion of the acid in the oil, as well as to the film forming and inhibiting properties of the oil. This is indicated by Test 1 in Table II, which was made during agitation of concentrated sulfuric acid with crude oil at atmospheric temperature. In this case, mild steel shows satisfactory resistance.

Tests 2, 3 and 4 were made in batch vessels where mixing, dilution and settling were carried out in the same vessel. Test 2 was made in the six-inch discharge line of the treating tank, and Test 3 in the vessel just above the discharge nozzle. Temperature conditions were about the same; and corrosion rates are somewhat similar. Under these conditions, treating tanks of Monel or Monel-lined steel or of lead-lined steel are commonly used.

In Test 4, the temperature was considerably higher than in other tests and this significantly increased the corrosion rates of the stainless steels, and to some extent, of lead. Test 5 was made in a batch vessel in which acid treatment, water washing and caustic treatment were all carried out in the same vessel and agitation was done with air. The caustic treatment increased the corrosion rate of lead, and air-agitation increased somewhat the corrosion rate of Monel during the acid treating cycle.

For pumps and valves handling the acid sludge from the treating units, a number of materials have been used satisfactorily, including Monel, acid bronzes, and the nickel-chromium-molybdenum-iron alloys containing silicon and/or copper, such as Worthite, Durimet 20, Durimet T, and Alloyco 20. In some cases, Monel valves trimmed with Hastelloy C or Illium are used. The selection of materials appears to depend upon general plant experience and principally upon the temperature of the sludge. Where abrasion or galling is a problem, the following combination of materials has been used satisfactorily in reciprocating pumps.

Liner	Cast "S" Monel
Piston	Monel (cast or wrought)
Rings	Monel (spring temper)
Rods	"K" Monel (age-hardened)
Valves	Monel, Hastelloy C, or Illium

Where separation of oil from sludge is done in high-speed centrifugals, the bowls of these centrifugals are commonly machined from Monel forgings.

In some cases it is the practice to remove the settled acid sludge from treating or settling tanks into separate vessels and dilute with hot water to accomplish a further acid separation and recovery. If only mild agitation is used in this process corrosion rates somewhat similar to those in Table II can be expected. However, if violent agitation with live steam is used there is a possibility of encountering high corrosion rates. The test results reported in Table III were obtained in the separating tanks of such a system. These two tests were made in adjacent separating tanks at the same refinery. The acid sludge is pumped to these tanks, diluted with hot water, and violently agitated with 120 psi. live steam until a "tar" separation occurs. At this point, the acid concentration of the acid layer is about 35 percent sulfuric acid (H_2SO_4), and in the "tar" layer is about 10-15 percent H_2SO_4. The acid layer is re-

moved and the "tar" layer pumped to a sludge oil storage tank. In Test 1, the corrosion test spool was suspended about four feet from the bottom of a 14-foot tank during the complete test. In Test 2, the test spool was originally located about six feet above the bottom of a similar tank, but after ten days it fell to the bottom and remained there for the balance of the 19-day test period.

TABLE III

Plant Corrosion Tests in Acid Dilution and Separation with Live Steam

Test 1. Immersed four feet above bottom of 14-foot separating tank during dilution and separation of sulfuric acid from acid sludge. Acid concentration in acid layer reduced to 35 percent sulfuric acid and in "tar" layer to 10-15 percent sulfuric acid. Violent agitation with 120 psi. live steam. Temperature 150-220° F. Duration of test 29 days.

Test 2. Same conditions as Test 1, except that test spool was suspended six feet above bottom of separating tank for 10 days, then fell to bottom of tank and remained there for balance of test period. Temperature 150-220° F. Total duration of test 19 days.

Test 3. Immersed three feet from bottom of sludge oil storage tank in sludge oil recovered from separators of Tests 1 and 2. Contains 10-15 percent sulfuric acid. Violent agitation with 120 psi. live steam. Temperature 150-220° F. Duration of test 22 days.

MATERIAL	Corrosion Rate, Inch Penetration Per Year		
	Test 1	Test 2	Test 3
Monel	0.074	0.028	0.056
Nickel	x	0.054	0.054
Inconel	x	0.072	0.068
18-8 Stainless (Type 302)	x	.....	0.077
18-8 Stainless (Type 304)	x	0.12	0.095
18-8 Mo Stainless (Type 316)	x	0.059a	0.072
18-8 Mo Stainless (Type 317)	0.48	0.045	0.077
25-20 Stainless (Type 310)	x	.....	0.093
Hastelloy B	0.12	0.031b	0.002
Durimet 20	0.16	.....	0.046
Worthite	0.080	0.017	0.027
Pioneer Metal	0.14	.....	0.062
Illium R	0.072	0.031	0.029
Alloyco 20	.....	0.017	.....
Chemical Lead	x	.....	0.020
Bronze (85-5-5-5)	0.090	0.010	0.050
Mild Steel	y	.....	0.14

x Specimens corroded entirely away. Original thickness 0.031 inch.
y Specimens corroded entirely away. Original thickness 0.062 inch.
a Pitted to maximum depth of 0.012 inch.
b Pitted to maximum depth of 0.016 inch.

The tank bottom was brick lined and the spool remained intact so that there was no galvanic corrosion of specimens involved. It is apparent from the lower corrosion rates in Test 2 that corrosive conditions were considerably less severe near the bottom of the tank than under the highly turbulent conditions existing above the steam inlet. The effect of steam agitation combined with high temperature is also shown by the test results in Test 3, obtained at the same plant in the sludge oil storage tank.

Under such highly corrosive conditions as those illustrated by Table III, it is apparent that brick-lined steel probably would have to be used for the separating tanks, with Hastelloy B and lead perhaps having some application in the storage tank. Where the acid sludge from treating processes is burned under the boilers, both Illium and cast hardened "S" Monel are used for burner tips.

Extraction and Polymerization of Olefins

In the production of alcohols from refinery gases, the first step usually involves absorption of the specific olefin in sulfuric acid. Acid concentrations of 65 to 95 percent are used, depending upon the alcohol being produced. Typical acid concentrations and temperatures are as follows:

Ethanol from ethene: 90-95 percent H_2SO_4 at 140-210° F.
Isopropanol from propene: 80-85 percent H_2SO_4 at 60-70° F.
tert-Butanol from isobutene: 65 percent H_2SO_4 at 50-60° F.

The second step in these processes involves the addition of water to ac-

complish hydrolysis of the sulfates to alcohols. In the case of ethanol production, the acid concentration is reduced to 60-65 percent or lower. In the case of tert-Butanol the acid concentration is reduced to perhaps 45 percent. The alcohols subsequently are stripped from the acid solutions with live steam. In the initial absorption stages, where 85 to 95 percent acid is used at low or moderate temperatures, mild steel equipment usually is satisfactory except where conditions of high velocity or turbulence exist. In the latter cases, the use of Types 304 or 316 stainless steel is indicated. In the mixtures involving 65 percent acid and lower, neither mild steel nor stainless steel would be satisfactory, and the use of Monel for absorption and cooling equipment would be indicated. In an attempt to simulate the acid-hydrocarbon mixtures involving 65 percent and 85 percent sulfuric acid, the laboratory corrosion tests reported in Table IV were made. Stoddard solvent was used to represent the hydrocarbon phase, and in each case was 15 percent by volume of the mixture. The mixtures were stirred sufficiently to keep the hydrocarbons in suspension.

A spool corrosion test was made in the inlet side of the channel head of a two-pass cooler handling the emulsion of 65 percent sulfuric acid and hydrocarbon in an isobutylene extraction plant with the results shown in Table V. Velocity at the inlet nozzle was eight feet per second. At some time during this 85-day test, the specimen holder came apart and at the end of the test the specimens were found lying on the dividing plate of the cast iron cooler head. Because of the possibility of galvanic protection during part of the test, these results probably cannot be considered entirely representative except for the corrosion rates of mild steel and cast iron.

In the separation and recovery of sulfuric acid in alcohol plants it may be necessary to handle 40 to 45 per-

TABLE IV

Laboratory Corrosion Tests in Mixtures of 65 Percent and 85 Percent Sulfuric Acid with Hydrocarbons

Test specimens immersed in mixtures of 15 percent by volume of Stoddard solvent and 85 percent by volume of corresponding acid. Mixtures stirred to keep hydrocarbons in suspension. Temperature 75° F. Duration of test 20 hours. Test 1. 65 percent sulfuric acid plus Stoddard solvent. Test 2. 85 percent sulfuric acid plus Stoddard solvent.

MATERIAL	Corrosion Rate, Inch Penetration Per Year	
	Test 1	Test 2
Monel	0.004	0.004
70-30 Copper-Nickel	0.007	0.008
18-8 Mo Stainless (Type 316)	0.093	0.023
Hastelloy B	0.003	0.001
Hastelloy C	0.0002	0.002
Illium R	0.003	0.003
Ni-Resist (Type 1)	0.005	0.11

TABLE V

Plant Corrosion Tests in Isobutylene Extraction with 65 Percent Sulfuric Acid

Test spool located in mixture of 65 percent sulfuric acid and C_4 hydrocarbons in inlet side of channel head of two-pass first stage emulsion cooler, Isobutylene extraction plant. Velocity at inlet nozzle eight feet/second. Test spool came apart some time during test and test specimens were found at end of test lying on dividing plate of cooler head. Average temperature 90° F. Duration of test 85 days.

MATERIAL	Corrosion Rate, Inch Penetration Per Year
Monel	0.0004
Nickel	0.0012
Inconel	0.0012
70-30 Copper-Nickel	0.0002
Ni-Resist (Type 1)	0.003
Cast Iron	0.035
Mild Steel	0.025

TABLE VI

Plant Corrosion Tests in Sulfuric Acid Regeneration Tower of Isobutylene Extraction Plant

Test spool located in bottom section of acid regeneration tower in 65-45 percent sulfuric acid. Temperature 100-240° F. Duration of test 14 days.

MATERIAL	Corrosion Rate, Inch Penetration Per Year
Monel	0.080
"S" Monel	0.11
Hastelloy A	0.045
Hastelloy B	0.040
Hastelloy C	0.065
Hastelloy D	0.071
Illium G	0.10
Copper	0.16
Aluminum Bronze (13% Al)	0.045
Corrosiron	0.002
Ni-Resist (Type 1)	0.67

TABLE VII

Laboratory Corrosion Tests in 45 Percent Sulfuric Acid at 240° F. (Ref. 2)

Test specimens immersed in quiet acid solutions without stirring. Duration of tests 4 to 10 days.

MATERIAL	Corrosion Rate, Inch Penetration Per Year
Monel	0.047
Nickel	0.20
Hastelloy B	0.009
Duriorn	0.001
Copper	0.081

cent acid at temperatures up to 240-250° F., and 60 to 65 percent acid and temperatures up to 275-300° F., both of which are highly corrosive conditions as indicated by the corrosion test results in Table VI. This test was made in the bottom section of an acid regenerator tower of an isobutylene extraction unit. It would be difficult to choose from this list, a suitable wrought metallic material for a tower lining. However, in another test in a similar tower, chemical lead was reported to show a corrosion rate of 0.022 inch per year, so that this material possibly could be used for lining such a tower if it could be properly supported mechanically. An acid brick lining over the lead lining would more likely be used. Karbate could be used for tower packing and for some other parts. Monel can be used for some applications with 40-45 percent sulfuric acid up to about 240° F., and with 60 percent acid up to about 210° F., under conditions of low velocity as indicated by the results of laboratory tests in Tables VII and VIII. However, at these border line temperatures, its corrosion rate is increased considerably by the velocity conditions existing in towers, pumps and piping. Data on the performance of Monel in sulfuric acid solutions at other temperatures are given in another publication.[3]

The selection of materials for pumps handling 45 and 65 percent sulfuric acid solutions at the above temperatures is a difficult problem in view of the velocities involved. The laboratory corrosion tests reported in Table IX were made under high velocity conditions in an attempt to approximate pumping conditions. It will be noted that, with 45 percent acid at 250° F., Hastelloy D and the 14.5 percent silicon cast iron materials were satisfactory. In 65 percent acid at 300° F., the only highly resistant materials would appear to be the silicon cast irons such as Duriron or Corrosiron. Wilkinson[4] has reported that Hastelloy D, Duriron, Corrosiron, Durimet 20, Worthite, and Alloyco 20, and in some cases Monel, silicon bronze, and red brass have shown suitable performance as pump and valve parts handling 40-45 percent acid up to about 240° F., but that with higher concentrations and temperatures, Hastelloy D and the silicon cast

irons usually are outstanding from the standpoint of corrosion resistance.

The hot acid polymerization processes employ 63 to 72 percent sulfuric acid at 165 to 200° F. to polymerize butylenes to gasoline range polymers. The results of corrosion tests in a polymerization tower and in a final settler vessel are given in Table X. Since the acid concentrations and temperatures existing in Tests 1 and 2 are similar, the higher corrosion rates for such materials as Monel and Hastelloy A in Test 1 would appear to be due to the higher velocities encountered in the tower.

Sulfuric Acid Alkylation

In the sulfuric acid alkylation processes, the hydrocarbons are emulsified with sulfuric acid of 95 to 100 percent concentration and reacted at low temperatures of 30 to 50° F. The nature of the process is such that the acid remains in fairly concentrated form, being diluted mostly with carbon to about 88 percent. With these high acid concentrations and low temperatures, mild steel has satisfactory corrosion resistance except where conditions of high velocity or turbulence are encountered as in pumps, valves, and return bends. For these locations, Type 304 or Type 316 stainless steel usually are satisfactory.

After initial separation of the alkylate from the spent acid, a portion of the latter usually is removed to other separator tanks where the acid is diluted to separate from it a layer of heavy hydrocarbons or "tar." This dilution may be accomplished with water, or with dilute sulfuric acid recovered from other sulfuric acid processes in the same plant.

TABLE VIII

Laboratory Corrosion Tests in 60 Percent Sulfuric Acid at 190-210° F. (Ref. 2)

Test specimens immersed in 60 percent sulfuric acid without stirring. Duration of tests 45 hours.

MATERIAL	Corrosion Rate, Inch Penetration Per Year
Monel	0.046
70-30 Copper-Nickel	0.033
80 Ni-20 Cr. Alloy	0.087
61 Ni-16 Cr-23 Fe Alloy	1.27
25 Cr-20 Ni Stainless (Type 310)	10.3
18-8 Stainless (Type 304)	10.6
Hastelloy A	0.16
Hastelloy C	0.25
Aluminum Bronze (10 percent Al.)	0.012
Chemical Lead	0.008
14.5 percent Si. Cast Iron	0.006
Ni-Resist (Type 1)	0.22
Cast Iron	0.89
Mild Steel	0.27

TABLE IX

Laboratory Corrosion Tests in Pure 45 Percent and 65 Percent Sulfuric Acid at High Velocity

Test specimens rotated at 1725 rpm giving velocities of 200 to 1000 feet per minute depending upon distance of each portion of specimen from center of rotating shaft. Duration of test 18 hours.

Test 1. In 45 percent sulfuric acid at 250° F.
Test 2. In 65 percent sulfuric acid at 300° F.

MATERIAL	Corrosion Rate, Inch Penetration Per Year	
	Test 1	Test 2
Monel	0.059	.....
"S" Monel	0.048	1.3
Hastelloy A	0.014	.....
Hastelloy B	0.084	3.7
Hastelloy C	0.059	.....
Hastelloy D	0.013	0.20
Worthite	0.13	16.3
Durimet T	0.052	x
Illium G	0.11	0.82
Aluminum Bronze (13 percent Al.)	.....	1.1
Copper	1.06	.....
14.5 percent Si Cast Iron	0.004	0.0006

x*Specimens corroded away during test. Original thickness 0.062 inch.

Since the acid concentration may be reducted to 40 to 60 percent and temperatures may be as high as 240° F., corrosion in these recovery processes is likely to be severe and

TABLE X

Plant Corrosion Tests in Polymerization of Butylenes

Test 1. In mixture of 72 percent sulfuric acid with butylenes, butanes, and polymer gasoline in polymer gasoline tower equipped with bubble caps. Average temperature 175° F. Duration of test 237 days.

Test 2. Immersed in mixture of 70 percent sulfuric acid with butanes and gasoline polymer in final settler vessel. Pressure 150 psi. Average temperature 180° F. Duration of test 162 days.

MATERIAL	Average Corrosion Rate, Inch Penetration Per Year	
	Test 1	Test 2
Monel	0.016a	0.004
Nickel	0.014a	0.002d
Inconel	0.017a	0.011
Hastelloy A	0.010b	0.001
Copper	x	0.023a
Silicon Bronze	x	0.024a
Chemical Lead	0.0005c	.....
Ni-Resist (Type 1)	0.015	0.007
Cast Iron	0.070	0.095
Mild Steel	.....	0.039e

x Specimens corroded away during test. Original thickness 0.031 inch.

a Specimens perforated by localized corrosion. Original thickness 0.031 inch.

b Localized corrosion to maximum depth of 0.023 inch.

c Localized corrosion to maximum depth of 0.014 inch.

d Localized corrosion to maximum depth of 0.008 inch.

e Specimens perforated by localized corrosion. Original thickness 0.062 inch.

TABLE XI

Plant Corrosion Test in Dilution and Separation of Spent Alkylation Acid with Live Steam

Separator tank is partially filled with 35 percent sulfuric acid recovered from acid treating. Spent 86 percent alkylation acid is added, resulting in mixture of 58 percent sulfuric acid and "tar" from which acid layer settles. Test made in 35 to 58 percent acid layer, five feet above outlet of 10-foot deep conical bottom of tank. Total depth of tank 27 feet. Violent agitation with 125 psi. live steam. Temperature 150-260° F. Duration of test 16 days.

MATERIAL	Corrosion Rate, Inch Penetration Per Year
Monel	0.13
Nickel	x
Inconel	0.29
18-8 Stainless (Type 302)	0.31
18-8 Stainless (Type 304)	x
18-8 Mo Stainless (Type 316)	x
18-8 Mo Stainless (Type 317)	x
25 Cr-20 Ni Stainless (Type 310)	x
Hastelloy B	0.11
Durimet 20	0.18
Worthite	0.24
Illium R	0.078
Pioneer Metal	0.18
Bronze (85-5-5-5)	0.25
Chemical Lead	0.083
Mild Steel	0.67

x Specimens corroded entirely away. Original thickness 0.031 inch.

of the same order as the rates shown in Table VI. If the mixture is agitated with steam during the dilution process, corrosion may be extremely severe as indicated by test results given in Table XI. In this case, the spent 86 percent alkylation acid was diluted with hot recovered 35 percent acid to 58 percent concentration, the mixture being violently agitated with 125 psi. live steam. In such a case the separator tank would have to be brick lined with necessary metallic parts of Duriron, Corrosiron, Hastelloy D, or possibly an alloy composition such as Illium. Piping handling the hot acid probably would be lead-lined or carbon-lined.

Reconcentration of Acid

In the larger refineries it is customary to recover the used sulfuric acid by evaporation. The acid leaves the separator at 40 to 60 percent concentration and is evaporated to about 93 percent concentration in several stages. Sometimes diluted treating acid in concentrations as low as 10 percent may be sent to evaporators. Lower stages of concentration may be accomplished at atmospheric pressure, but in the higher ranges of concentration, evaporation usually is done under vacuum. Even with vacuum, boiling temperatures are high enough that corrosive conditions are quite severe. The evaporator bodies usually are of steel, lined with lead, and this covered with acid brick. Heating

tubes commonly are of Hastelloy D[5] and other parts of Duriron, Corrosiron, and carbon are used. There is some indication that Hastelloy D may suffer accelerated attack in boiling 55 percent acid and this is being investigated.

Examination of the corrosion test results will show that some of the sulfuric acid solutions, particularly those from 40 to 65 percent concentration, are being handled at or near a border-line temperature where relatively small changes in temperature can make a considerable difference in the corrosion rates of a number of metals and alloys. Also, near these border-line temperatures, the effect of velocity on corrosion rates of these materials is very pronounced. It is apparent that close control of acid temperatures and velocities to prevent them from getting higher than is actually necessary, will do much to prolong the life of operating equipment.

Wachter, Treseder and Weber[6] have shown that the continuous presence of small amounts of arsenic (up to 0.2 percent by weight) in sulfuric acid solutions, is very effective in inhibiting corrosion of carbon steel in strong hot acid solutions, particularly in the concentration range from 50 to 72 percent. In such solutions the inhibiting effect was very marked even at peripheral velocities of 12 to 14 feet per second. A few tests with Monel in 71 percent acid at 170° F. indicated that arsenic additions to the acid might also serve to inhibit corrosion of this alloy under some conditions. This and other experience has demonstrated that the use of corrosion inhibitors can effectively reduce corrosion in recirculating acid systems, and would appear to justify an even more extensive investigation of possible inhibitors, especially under acid conditions where the selection of construction materials now is very limited.

The author wishes to acknowledge the assistance provided by Dr. W. A. Wesley and his associates in The International Nickel Co., Inc., Research Laboratory, Bayonne, N. J., where the laboratory corrosion studies, not otherwise credited, were made.

References

1. ASTM Standards, Part 1, 522 (1944).
2. Unpublished data from private communications.
3. Technical Bulletin T-3, Monel in Sulfuric Acid, The International Nickel Co., Inc., December, 1942.
4. Wilkinson, E. R., Mechanical and Metallurgical Control of Sulfuric Acid Corrosion in Petroleum Processes, Corrosion, **3**, 252-262 (1947) Mar.
5. Burke, J. F., and Mantius, E., Concentration of Sulfuric Acid Under Vacuum, Chem. Eng. Prog., **1**, 237-246 (1947).
6. Wachter, A., Treseder, R. S., and Weber, M. K., Arsenic as a Corrosion Inhibitor in Sulfuric Acid, Corrosion, **3**, 406-414 (1947) Mar.

EDITOR'S NOTE: This general paper on sulfuric acid corrosion is presented by the editor, who concurs with E. R. Wilkinson, Corrosion 3, 262 (1947) in his statement that ". . . every opportunity should be taken to exchange information on corrosion with sulfuric acid in different locations and under different conditions." The plant test data presented will be very valuable to operating engineers.

Selection of Protective Coatings For Metals*

*By K. G. Compton**

THE ESTIMATED cost of corrosion to the world of upwards of $10 billion per annum would be multiplied many, many fold were it not for the use of protective coatings. In this country alone, the annual cost of the raw materials used in the protective coatings industry exceeds $500 million** The labor cost of application of protective coatings is several times the raw materials' cost, so it is evident that the proper selection and evaluation of protective coatings assumes a role of considerable importance to the economy of the country.

For purposes of discussion, protective coatings are usually divided into the classes of metallic, organic, inorganic, and temporary, with each class containing many subdivisions, largely based upon composition. In general, the kinds of coatings that will achieve the desired results are first determined, and then a final selection made on the basis of economic consideration such as cost, facilities available and customer preference.

Metallic coatings are divided broadly into the sacrificial type, of which zinc is the most widely used, and the noble type, as represented by nickel. Sacrificial types of coating protect the basis metal by virtue of its anodic potential in the galvanic cell formed by it and the basis metal. Zinc and cadmium are usually employed on ferrous alloys and iron, while pure aluminum is extensively used on copper bearing aluminum alloys. Because rapid corrosion of this type of coating by itself occurs in many environments in addition to its sacrificial behavior, care must be exercised in its use. For example, a figure of three-tenths of an ounce per square foot is frequently given as the corrosion rate of zinc coatings in outdoor industrial atmospheres, such as those around New York, Pittsburgh and Chicago.

The noble metallic coatings, such as nickel, afford protection by virtue of the impervious envelope they provide and their own intrinsic resistance to corrosion. Hence it is imperative that the coating be of a thickness sufficient to provide a minimum of porosity. Frequently, combination coatings are employed either to enhance appearance or to improve corrosion resistance.

★ A paper presented at the Symposium on Modern Metal Protection in Cleveland, Ohio, Sept. 1, 1947.

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** Paint sales exceed $700 million and metallic coating materials sales exceed $100 million. Some of the paint will be used for purely decorative purposes and on materials other than metal.

Organic coatings which function largely as an envelope to exclude the environment are usually divided into the following six general classes: 1—Paints; 2—Varnishes; 3—Enamels; 4—Lacquers; 5—Films of Plastic; 6—Bitumens.

Paints, varnishes and enamels are comprised of various combinations of drying oils, hard resins, pigments and, in some cases, driers. They may be air drying or may require baking but they all have in common, the absorption of oxygen from air to effect a cure. The term, paint, usually applies to mixtures of drying oil and pigment; varnish to mixtures of drying oil and resins; and enamels to mixtures of varnishes and pigment.

In its purer use, the term, lacquer, applies to organic finishes that harden or dry by evaporation of solvents. Lacquers employ an exceedingly large variety of material, such as cellulosic derivatives, vinyls, acrylic esters, plasticisers, etc. Films of plastic in many cases resemble lacquers, but may be applied by means which do not involve solvents. Bitumens include the whole family of asphaltic, petroleum and tarry resins, and may be applied from melts or by means of solvents.

Inorganic protective coatings may be divided into surface reaction products of which the oxide film produced by anodizing aluminum is representative and additive coatings such as vitreous enamel. These coatings function as barriers between the basis metal and the corroding

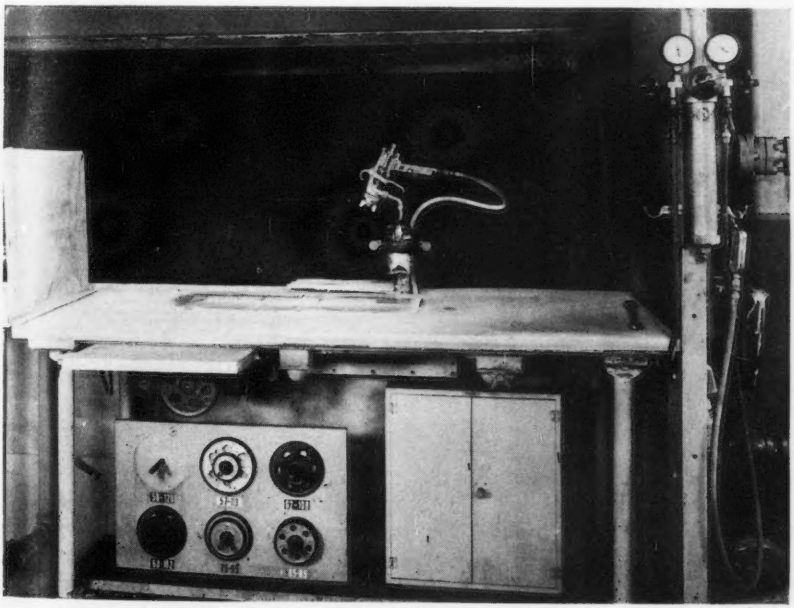


Figure 1—Automatic spraying machine.

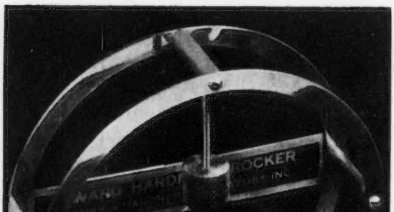


Figure 2—Sward Hardness Rocker.

environment. Some of the surface reaction coatings such as that produced by phosphatizing serve largely as an aid in securing good adherence between the basis metal and an organic finish.

Temporary protective coatings include the whole family of waxes, greases and strippable films. They are used primarily during storage and shipment of material which may not require protective coatings when placed in service. These materials frequently have corrosion inhibiting agents incorporated in their composition.

In many cases, a protective coating must enhance appearance, or fulfill some physical need such as abrasion resistance, in addition to providing protection against corrosion. When selected, it represents a compromise of such factors as these and cost. Processing limitations frequently determine the ultimate selection at some sacrifice in the desired qualities of the protective coating. Usually the type of coating is fairly clear-cut, or any number of coatings will be equally satisfactory from the purely protection standpoint. In general, large objects are limited to organic coatings due to process limitations and small objects which are handled a great deal are limited to metallic coatings.

Various Tests Used

In the determination of the suitability of a protective coating many tests are employed. Some of these consist in exposure to accelerated environmental conditions, and others in physical tests on the coatings. Many of these tests must be made on a comparative basis, because the testing conditions are not reproducible, or the results do not lend themselves to numerical evaluation. Corrosion tests consist in the exposure of suitable specimens to various environments and determining the point at which attack upon the basis metal begins or reaches a maximum allowable level. These tests usually take the form of outdoor atmospheric exposure, immersion in sea water or chemical solution, or burial in the soil. Salt fog chambers, humidity room and cabinets, and the "so-called" weathering machines are well-known examples of the accelerated type of tests, and do not need elaboration here. Frequently the thickness and/or combination of coatings is varied as a means of determining rates of deterioration.

Physical Tests

The physical tests on metallic coatings are largely limited to bending or wear tests; in the case of inorganic coatings both wear and some type of shock test may be employed; but the types of tests are extensive

in the organic coating field. Most of the physical tests on organic coatings seek to give an evaluation of properties related to the adherence of the coating to the basis metal; its distensibility, abrasion resistance, hardness, and resistance to scratching or mar. Many testing tools have been developed and methods of employing them have been described in the literature. As there has been little integration of these tests in the study of protective coatings from the standpoint of coating deterioration, some of these are reviewed here.

Physical properties of many organic coatings vary widely with the thickness of the coating; so one of the first requisites of testing is to produce uniform films of the nominal thickness expected in the product. Many methods have been employed such as "doctor blade," dip-coaters, spinning flow tables, etc., but the author considers the method employed in Bell Telephone Laboratories as most generally satisfactory. This apparatus is shown in Figure 1.

Various methods of determining hardness have been developed, notably those based on indentation, such as Pfund and Knoop Indentor methods, the swinging beam or Sward Rocker Test, and microscratch lists. The Pfund Hardness Test is perhaps the most generally useful, and is based upon the indentation produced in the film by a spherical tool under various conditions of load. It has the advantage over other indentation methods in that the measurement is made while the tool is in contact with the film and is unaffected by its elasticity. It is affected by cold flow and by the support of the basis metal when the film is thin. Where the superficial hardness is important in coatings which may be sanded and polished, the rocker test has been found more useful than the indentation methods. See Figure 2.

In testing the distensibility of protective coatings, the mandrel tests are recommended as against tests of the detached film. One such mandrel test developed in the Bell laboratories has been found to be generally satisfactory and has been

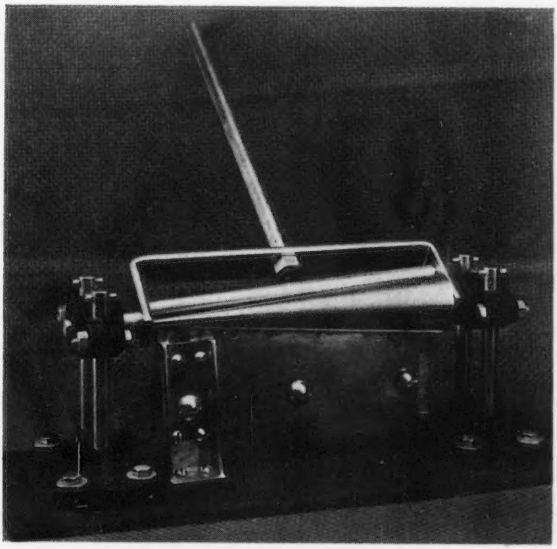
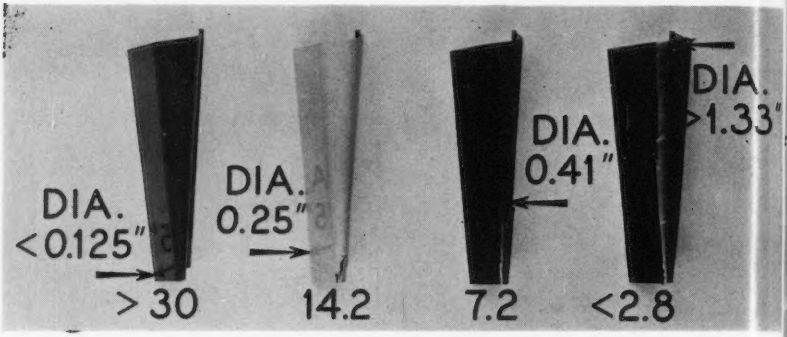


Figure 3—Conical Mandrel for Distensibility Tests.



Distensibility in Percent

Figure 4—Bent test specimens showing distensibility.

specified in Government and ASTM specifications. The apparatus and typical specimens are shown in Figures 3 and 4.

For testing the abrasion resistance of protective coatings, the apparatus shown in Figures 5 and 6 is desirable. This avoids many of the difficulties encountered in the use of abrasive wheels or belts. In this impingement type test, soft rubbery materials may give large values of abrasion resistance, because the abrasive particles bounce off the surface of the specimens. This illustrates the necessity of integrating the knowledge obtained from one test with that obtained from the others. Unless this film is shown to be tough by the other tests, its abrasion resistance may be meaningless, or may merely indicate an incomplete cure.

Tests for the measurement of resistance to impact are usually based upon falling balls or hammers. A useful machine for this purpose is shown in Figure 7, and the impact pattern is illustrated in Figure 8. The properties of brittleness, softness, adherence and toughness are all factors in the performance of a protective coating in this test.

No satisfactory test has been developed for the direct measurement of adherence, but many of the "scratch adherence" tests have great practical value. Several of these devices are shown in Figures 9, 10, 11 and are based on the load applied to a scraping tool which is required to bring about removal of the film.

In addition to revealing the initial physical properties of a protective coating, the tests described may be used to follow the deterioration of a coating during an exposure test. On a comparative basis, much time can be saved in reaching an evaluation. These methods have been successfully employed in the Bell system, where protective coatings must give many years of service. They are used to control purchases of protective coating materials under specifications and to evaluate new materials.

The following constitutes the author's evaluation of various protective coatings based upon many years

of testing, observation and research in this field. It is anticipated that suppliers of coating materials and some users will differ with the author. It is impossible to make a precise evaluation due to the extremely complex relationship between physical and chemical properties, test methods and service conditions. The elements of judgment and experience play important roles in selection of protective coatings and frequently many alternatives are equally satisfactory.

Zinc and Cadmium

Zinc and cadmium, providing cathodic protection at pores and scratches, may be applied in thinner coats than most other coating metals, but are themselves susceptible to corrosion. On a general basis, there is little to choose between the two but there is a distinct difference in behavior. Cadmium will corrode more readily at lower relative humidities than zinc in the presence of organic fumes. In an uncontaminated atmosphere, with condensation and slightly elevated temperatures, cadmium out-performs zinc. The same is true in salt fog tests. A salt fog test will consume about 0.00025 inch of zinc coating in 200 hours. A surface reaction treatment with phosphates or chromates will considerably improve the performance of both coatings in the salt fog or humidity and condensation tests. The rate of outdoor corrosion of zinc coatings has been given as 0.3 oz/ft^2/year in industrial atmospheres, 0.07 in marine, and 0.05 in rural atmospheres. Both metals are relatively soft and will not stand much abrasion. The cadmium plating bath appears to have better throwing power and hence more uniform coatings may be obtained. The use of both materials is largely limited to iron and ferrous alloys. Coatings 0.0002 inch thick are recommended for normal indoor use and outdoors upwards of 0.0025 inch.

Nickel, tin, copper and chromium must be built up to a point where

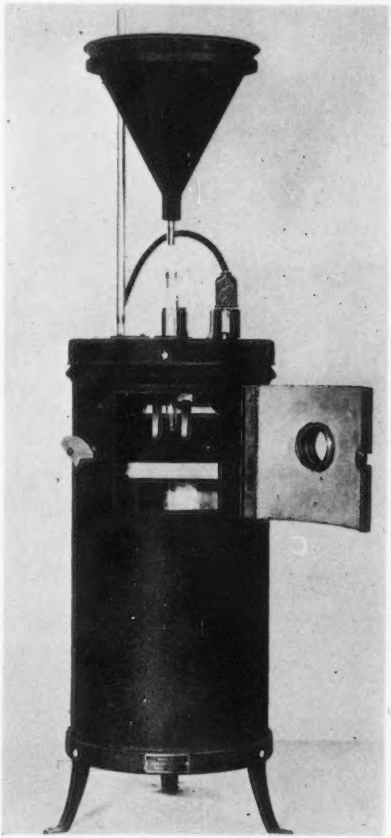


Figure 5—Abrasion Testing Apparatus. Test Panel is mounted in machine at 45° to and in contact with nozzle which directs a controlled carborundum blast on a small spot on the surface of test film.

porosity is diminished to a tolerable level. For mild indoor exposure, thicknesses of 0.0005 inch on steel are a practical minimum for reasonable performance, whereas for outdoor exposure coatings 0.002 inch thick are required to give satisfactory results. In general, equal thickness of nickel and tin have about the same protective value. Possibly tin is slightly better but copper is definitely much poorer. Due to its own high order of corrosion resistance, a very thin film of chromium over nickel of sufficient thickness to eliminate porosity gives a remarkable improvement in corrosion resistance. Chromium is extremely hard and is not easily stained. Nickel is tough but may be under an enormous tensile strain from the plating process and if adherence is poor will give trouble from peeling. The throwing power of tin is the best, followed by copper and nickel, with chromium being very poor. Zinc base die castings require a heavy copper coating (0.005 inch) followed by nickel-chrome or other combinations of metals.

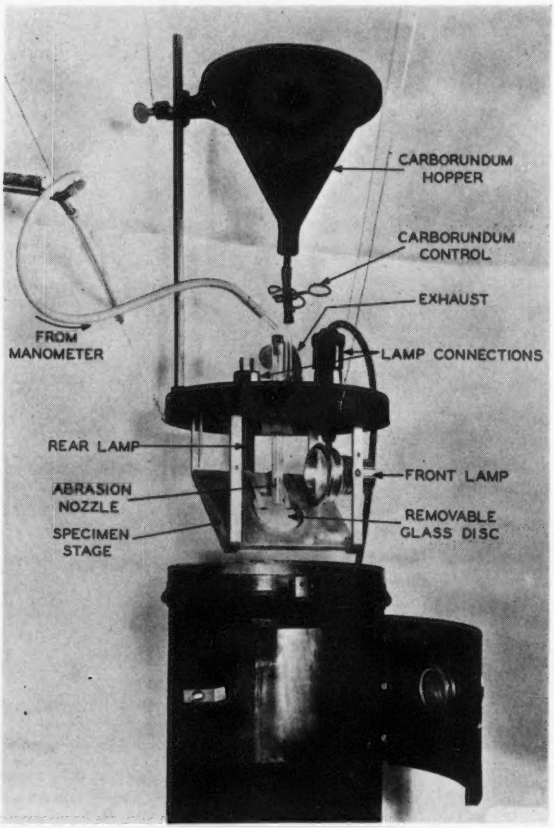


Figure 6—Details of Abrasion Testing Apparatus.

Silver, gold and brass are primarily used for ornamental purposes and generally are dependent upon an under-coat for protection. Iron, cobalt, indium and other metals are not normally used as protective coatings. In recent years there has been a growing trend towards alloy plating as protective coatings. Lead is not plated to any great extent as a protective coating, but there is some activity in the hot-dipping field. When lead coatings are comparable to hot-dipped zinc coatings in thickness, the protective behavior is quite good.

Phosphate coatings on steel have little protective value unless fortified with an organic material. However, both phosphate and chromate surface reaction coatings on zinc and aluminum improve corrosion resistance.

Under tropical or marine atmospheric exposure the inception of corrosion is considerably delayed. The anodic oxide coating on aluminum is extremely successful if properly applied and sealed. The author has had specimens of 2S aluminum which had been anodized and sealed in dichromate in a salt fog test for upwards of four years without any sign of corrosion. Several oxidizing processes for treatment of cuprous alloys produce good corrosion resistant coatings, but the same type treatment for steel is not particularly effective without a supplementary oiling treatment.

Ceramic coatings offer good protection but are brittle and will not stand flexing or severe impact. They are largely limited to sanitary goods. Freedom from porosity is an essential requirement.

Selection of organic coatings constitutes a rather complex problem due to the great range in properties and composition. The user is confronted by a vast system of trade names and so called "trade secrets." Selection of organic coatings can be just as scientific as any other once this fog of secrecy is penetrated. The ingredients that enter into the composition of an organic finish, in general, determine its properties but faulty processing can have a profound effect on durability and physical characteristics.

Figure 7—Impact Testing Apparatus.

The principal drying oils used in organic finishes are tung, linseed, dehydrated castor and soya. Their reactivity is in this same order and, of the last three, so is their hardness characteristics in any given vehicle.

Most paints are comprised of processed linseed oil and pigment. The durability, chalking characteristics, etc., are largely a function of the pigment combination. Varnishes are quite limited in their application as protective coatings, but when combined with suitable pigment combinations become enamels which constitute the most widely used type of organic protective coating for metals.

The amount of drying oil em-

ployed with a given amount of hard resin in an enamel vehicle is termed the oil length. Usually it is stated as the number of gallons of oil per 100 pounds of resin. Increasing the ratio of oil to resin is termed "lengthening" and decreasing is termed "shortening." Thus a 12½-gallon tung oil-phenolic resin varnish is said to be a short-oil varnish. Lengthening tends to increase flexibility, shortening to increase hardness for a given cure or may hasten the drying of the coating.

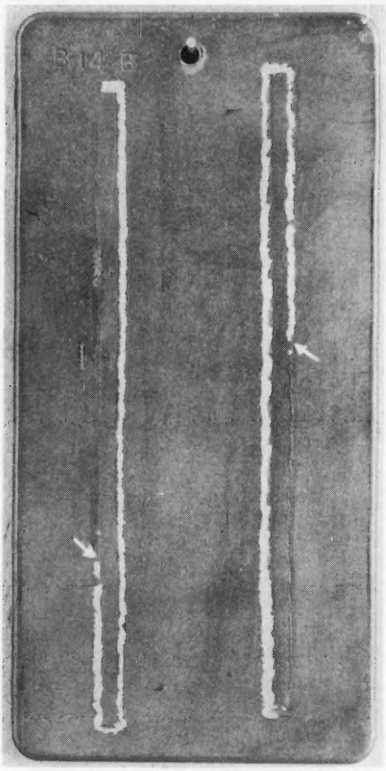


Figure 8—Impact pattern. Arrow indicates position on impact pattern where finish was first shattered. This also represents the minimum energy (in rpm. of impact tool) necessary to disrupt the film.

The hard resins used in enamels are quite diverse. Various phenolic resins are employed, but they are usually limited to the darker shades of color. The most widely used type of resin, the alkyd, consists of the reaction product of a polyhydric alcohol with a polybasic acid, the most common of which is that obtained from glycerol and phthallic anhydride. Other alkyd components include maleic acid, pentaerythritol, sebacic acid, glycols or hexahydric alcohols in combinations with themselves or with either of the former two materials. As modifiers of the alkyds, resins such as malamine, and urea-formaldehyde are frequently employed to speed baking or improve the hardness of the enamel. Ester gum, a rosin derivative, has long been employed as a constituent of enamel vehicles.

Based upon the foregoing limited discussion of enamels, the effect of variations in composition upon physical properties of protective coatings can be stated in general terms. Let us take for example a glyceryphthallate drying oil vehicle. As the oil length is varied, flexibility and hardness vary. Changing from linseed through dehydrated castor to soya as the drying oil component brings about a decrease in hardness, an increase in flexibility and a decreased tendency to yellow or darken upon baking or aging, for a given cure. In air dried materials, decreasing the oil length is generally associated with decreasing adherence. As indicated, modification with melamine or urea-formaldehyde resins increases the rate of cure and hardness, but may entail some sacri-

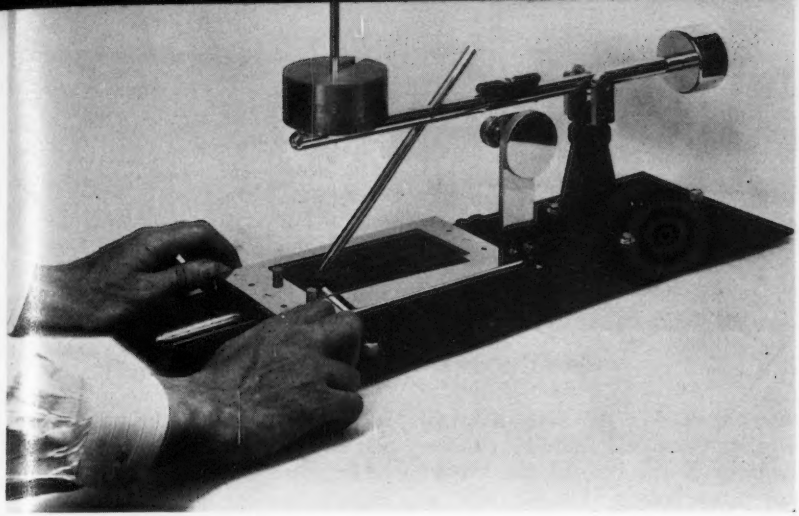


Figure 9—Scratch, Adhesion and Mar Tester.

fice in adherence and flexibility. The pigment volume concentration is important, because increasing the pigment has an effect of hardening and embrittling the coating. In any given system a moderate pigment volume concentration tends to have better durability.

A 35 to 40 percent phthallate linseed glycerylphthallate enamel baked for an hour at 350° F., will give an extremely tough adherent flexible and mar-resistant coating. Modification by incorporating 15 percent melamine or urea-formaldehyde will permit baking under infra-red for as little as ten minutes. The flexibility, adherence, and impact resistance will have been slightly impaired. If pigmented in the light shades, the linseed oil will be found to darken objectionably. This can be avoided by changing to soya oil with a corresponding change in hardness under similar conditions of cure. The same adjustments in composition can be made in other combinations of materials to achieve the requisite properties. Many formulators prefer phenolic resins in a vehicle where water resistance is of importance. Driers such as lead naphthenate are usually employed in air-drying enamels.

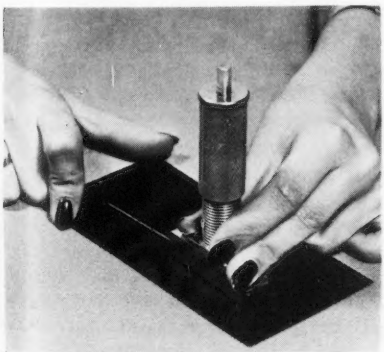


Figure 10—Hand Scratch Adhesion Tester.

Lacquers, embodying the wide variety of constituents that they do, can be dealt with in general terms. They are comprised of the principle lacquer film constituent such as nitrocellulose, vinyl resin, or acrylic ester, an additive to improve the adherence to metal, for example, de-

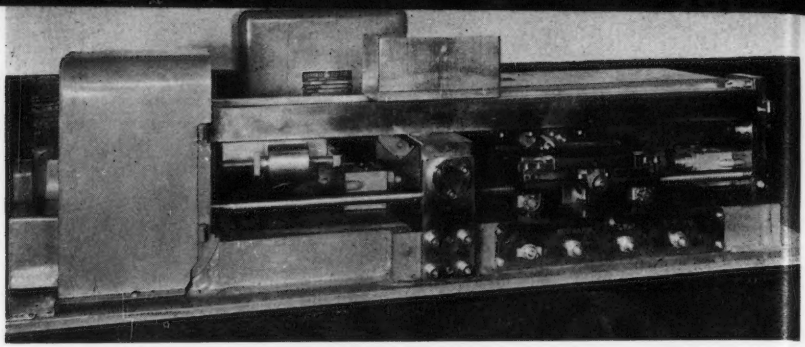


Figure 11—Automatic Scratch Adhesion Tester.

waxed damar in the case of nitrocellulose lacquers, maleic acid derivatives in the case of the vinyls, etc., sometimes a hard resin to harden up the film and a plasticizer to secure flexibility. The latter may be a non-drying alkyd or any of a large number of compounds of low volatility such as tricresyl phosphate, dibutyl phthallate. Usually lacquers are employed over primers to give improved adherence.

Films of plastic may be cemented to the metal or applied in the molten form and are closely related to lacquers in many properties. Bitumens are largely used on underground structures or in chemical atmospheres and are generally well known. Softening points, brittleness at low temperatures, cold flow, and adherence are factors to be considered in their selection.

Employing the test methods outlined above, it will be found that properly formulated baking enamels have an entirely different order of protective value as coatings from most other organic coating materials. Lacquers and air drying enamels have about the same level of adherence, but many enamels will not stand the same amount of impact as good lacquers. The fast drying characteristics of lacquers are certainly factors in their favor. Pigmentation improves the weather resistance of all types of organic finishes. Generally, multiple coats of organic finishes are desirable to provide freedom from runs and sags, porosity; and they permit complete curing.

Temporary protective coatings received great publicity during the war; when spare parts had to be transported and stored under unfavorable conditions. The choice of a grease-type coating as against a strippable film depends to a large extent upon the handling involved. A primary requirement is ease of removal.

In conclusion, the procedure to be followed in selecting a protective coating can be stated simply. First determine the requirements both from the standpoint of the expected exposure and physical properties required and from the standpoint of the customer's preference. Then from the tests described or information based on similar tests or general background knowledge of the behavior of materials, select the coatings which will meet the requirements. At this point it becomes necessary to effect a compromise of all the related factors, not the least of which are cost and available facilities.

Control of External Corrosion on Plantation Pipe Line*

*By Alan C. Nelson**

PLANTATION PIPE LINE was constructed in the latter half of 1941. Extending from Baton Rouge, La., to Greensboro, N. C., (Figure 1), it lies almost entirely in that soil group known as "The Red and Yellow Soils." In the upland areas this soil is well drained, well aerated and of extremely high electrical resistance. Pipelines laid in this soil rapidly develop numerous pits which, before complete penetration, seal over with a closely adhering protective layer of rust. The result is that few leaks occur and has led to the general practice of laying pipelines uncoated.

Coatings Applied in Localized Areas

Plantation has followed the general procedure of coating only in localized areas of low resistant soil and at river and stream crossings. As the line lies across the direction of general drainage (Figure 2), it crosses numerous rivers and streams, resulting in a great number of short-coated sections. For example, one 52-mile section in North Carolina is coated in 59 spots for a total of 4.75 miles. Fifty of these spots have an average length of 223 feet. There are two areas of low resistant soil through which, as mentioned, the pipe is coated. The first of these extends from Baton Rouge to the Louisiana-Mississippi state line and the second is a 30-mile length in Alabama beginning near the Mississippi-Alabama boundary.

Four Phases of Corrosion Control

Corrosion control on the system is divided into four major phases. First of these is the application of cathodic protection to the stations which have suffered numerous leaks in small control lines. Second is the application of cathodic protection to tank bottoms. This problem is probably the least pressing as conditions are such that no leaks are anticipated for some time. Third is the application of cathodic protection to the main line with its numerous spots of coating. Fourth, and of ma-

★ A paper presented at the Annual Meeting of NACE in Chicago, Ill., April 7-10, 1947.

* Plantation Pipe Line Co., Atlanta, Ga., now affiliated with Trans-Arabian Pipe Line Corp., Jacksonville, Fla.

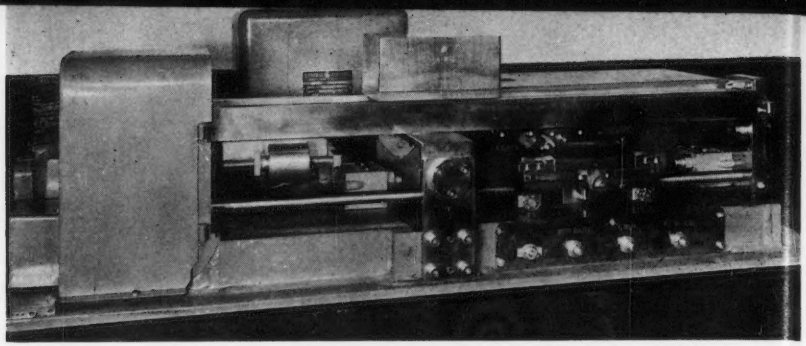


Figure 11—Automatic Scratch Adhesion Tester.

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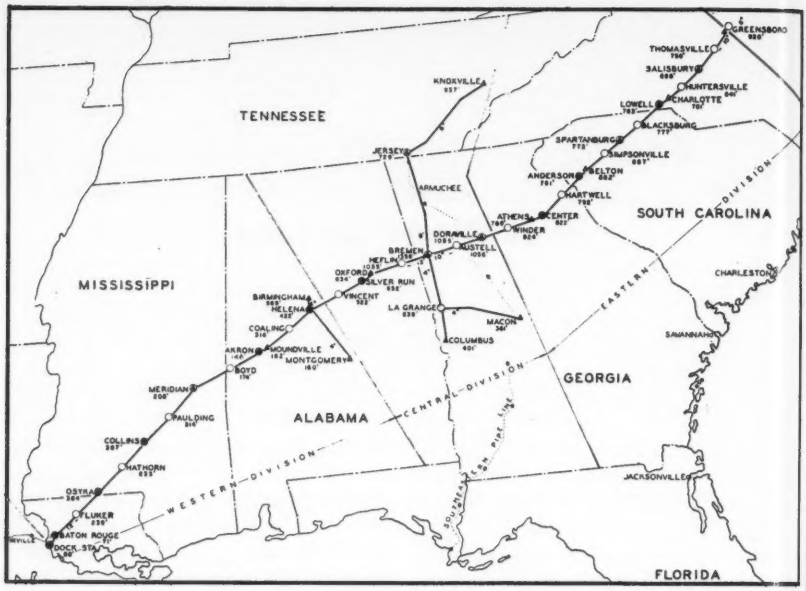


Figure 1—Map of Plantation system.

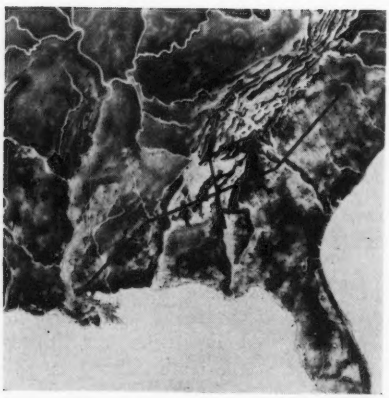


Figure 2—Location of line with respect to drainage.

jor importance, is the drainage of strong fluctuating stray current at a number of electric railway crossings in the Carolinas.

Corrosion Control In Stations

To date, the only leaks have been in the control piping of the stations and it has been on this phase of the problem that efforts have been concentrated. Investigation revealed a number of conditions responsible for the corrosion. Under the pump room floor this piping was in sand-filled trenches. To keep them spaced they were laid on two by fours, with nails driven on each side. In every case,

piping was corroded to a flat and leaking surface where it contacted the wood. Conduits were found to be pitted on the outer side of bends. The piping is all bonded to an extensive copper ground-bed. In many cases, the main cause was the drastic reduction in resistivity of soil immediately surrounding the pipe. This reduction is attributed to a layer of crushed blast furnace slag used to cover the manifold area. In one case, measurements taken under this slag read as low as 2000 ohms per centimeter cubed, whereas measurements taken just outside of the area read as high as 25,000 ohms per centimeter cubed. In the Eastern Division, where manifold areas are covered with crushed granite, the resistivity has been only slightly lowered. In this area, corrosion was caused mostly by strong stray currents which were flowing through the stations.

As new control lines were placed, they were coated with coal-tar enamel and the wood forms were eliminated. Later insulating gaskets, designed for use in large tongue-and-groove flanges, were installed where needed and cathodic protection provided by either rectifiers or magnesium anodes. The first few installations quickly proved that rectifiers utilizing ground-beds installed at a distance from the piping, as is generally recommended, would give no results in the extremely high-

TABLE I
Typical Results of Cathodic Protection Installations

STATION	Type of Protection	Soil Res. Ohm-$^{c}/CM^{3}$	Original P/S—$CuSO_4$ MV	Resulting P/S—$CuSO_4$ MV
Baton Rouge..	Rectifier	1,500	590	920
Fluker.....	12 Anodes	4,000	660	830
Osyka.....	20 Anodes	5,000	650	870
Hathorn.....	12 Anodes	3,000	765	875
Collins.....	20 Anodes	7,000	640	750
Meridian.....	Rectifier	4,000	710	800
Arkon.....	20 Anodes	2,000	675	750
Silver Run....	20 Anodes	7,500	670	950
Bremen.....	Rectifier	40,000	455	465
Heflin.....	12 Anodes	40,000	455	740

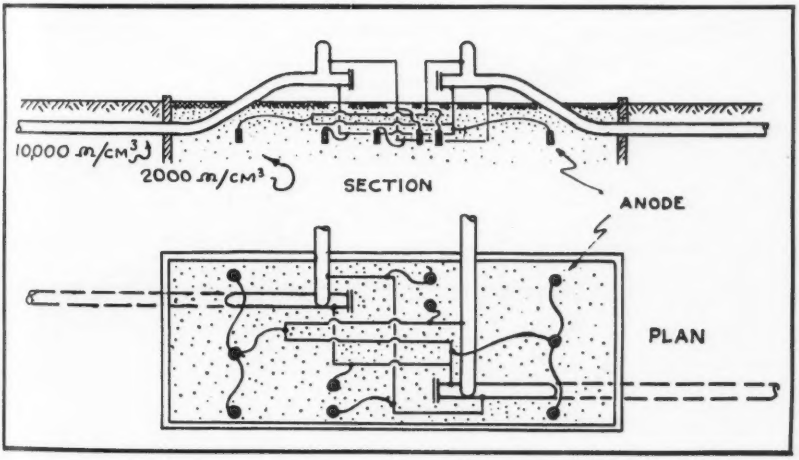


Figure 3—Galvanic anodes on station piping.

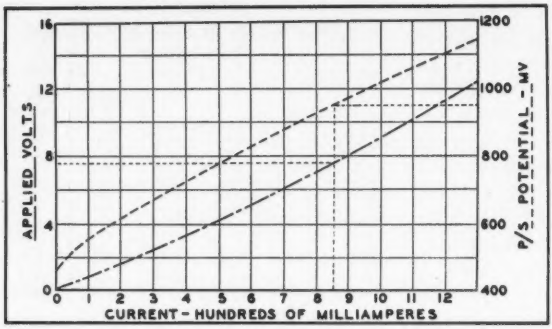


Figure 4—Results of applied voltage on magnesium anode installation at Winder, Ga.

resistant soil. Magnesium anodes, however, buried in the lower resistant soil under the slag (Figure 3) gave good results in most cases (Table I) and some results in every case. As it was imperative that some sort of protection be applied immediately at a large number of stations, and as the anodes could be installed at the relatively low cost of $225.00 per station, (Table II), it was decided to go ahead with a uniform installation of the anodes, which would later be checked and adjusted as found necessary.

This later check revealed that some stations needed added protection. Experiments showed that a small capacity rectifier using the anodes as a well distributed and low resistant ground-bed would give the desired results. At the Winder,

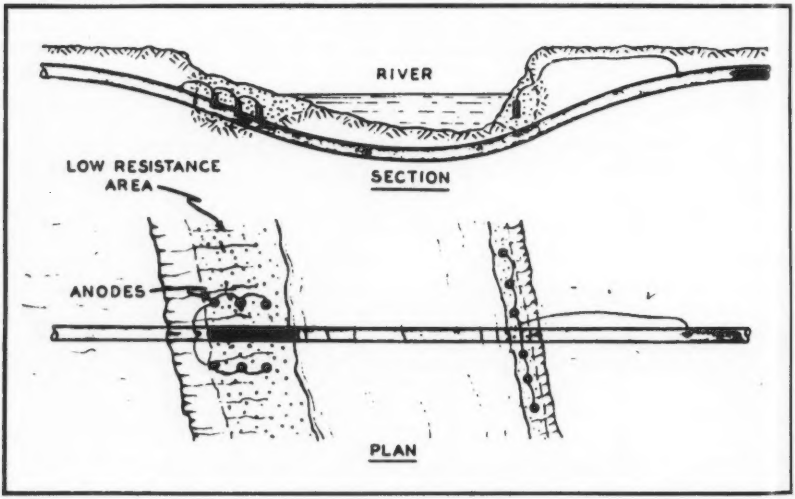
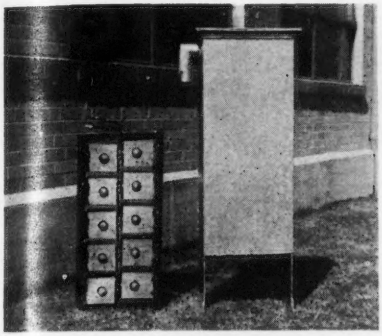


Figure 5—Location of galvanic anodes on river crossing.



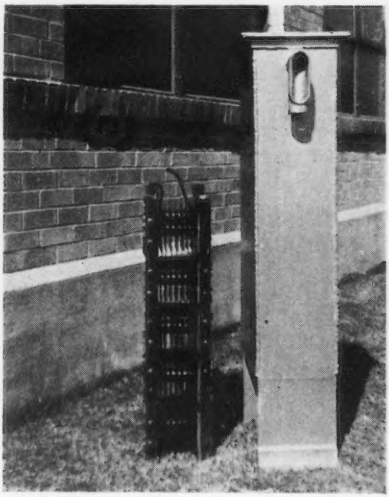


Figure 6—Views of stray current drainage unit. Front view, left illustration; side view, right illustration.

Georgia, station, 8 anodes in 20,000-ohm soil (surrounding soil 30,000 plus) were delivering 105 milliamperes at 0.92 volts, and had raised the pipe to soil potential from 455 millivolts to 570 millivots (Figure 4). Application of six volts potential increased the output to 740 milliamperes and the pipe-to-soil potential to 900 millivolts. Application of 12 volts potential increased the output to 1300 milliamperes and the pipe-to-soil potential to 1150 millivolts.

It is now planned to install small rectifiers at a number of stations and to use the present magnesium installations as ground-beds. They should last approximately ten years, and can be replaced with scrap iron. It is estimated that such an installation could have been made originally at a cost of $300.00. Cost per year in this case would be less than $20.00

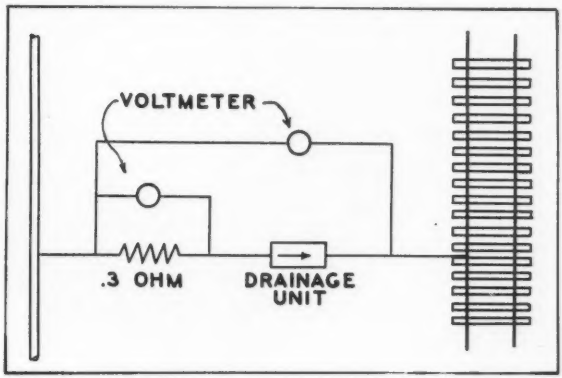


Figure 7—Connections for trial installations of stray current unit.

Figure 8—One-hour charts showing action of stray current drainage unit.

TABLE II

Installation Costs of Magnesium Anodes and Rectifiers

ITEM	Magnesium	Rectifier
20 Anodes	$100.00	$.....
Backfill	14.00	.....
Wire, Solder, Misc.	6.00	.....
Rectifier	.....	500.00
Cable	.....	100.00
AC Connection	.....	75.00
Ground Bed	.....	150.00
Total Material	$120.00	$825.00
Labor	30.00	250.00
Supervision	15.00	50.00
Crew Expense	30.00	100.00
Vehicle	10.00	50.00
Overhead	20.00	125.00
Grand Total	$225.00	$1400.00

and would compare favorably with the cost of the anode installations.

In the low-resistant soil areas, where the rectifier installations using a remote ground-bed operate satisfactorily, cost of installation for the large 30-volt, 50-ampere units averaged $1400.00. Cost per year is approximately $130.00. In this case, however, protection is also being applied to considerable line outside the station area.

Corrosion Control on Tank Bottoms

Magnesium anodes have been installed around all storage tanks owned by Plantation. Due to the large number of installations, time has not permitted a complete check on the results obtained. At Helena, however, readings taken on two tanks picked at random show that four anodes brought the pipe-to-soil potential up approximately 300 millivolts when measured at the tank rim, and 600 millivolts when measured remotely. Output of the individual anodes varies widely, ranging from 3 to 45 millamperes and 30 to 100 milliamperes on one tank.

Eight aluminum anodes have been installed on a trial basis. Two, buried in a backfill of lime, salt and calomel, are delivering 25 and 70 milliamperes. Six, buried in precast blocks of backfill furnished by the Aluminum Company of America, are delivering an average of 17 milliamperes each. This installation was made in December, 1946, and is being checked each month. Results to date are encouraging and further installations are contemplated.

Corrosion Control on the Main Line

On the main line, protection has been applied to the two main coated sections. A rectifier at Baton Rouge, delivering 28 amperes at 14 volts, fully protects 25 miles of coated line in the low-resistant soil out of that station. Pipe-to-soil potential has been raised from 550 millivolts to 1700 millivolts at the point nearest the ground-bed, and from 600 millivolts to 880 millivolts at a point 25 miles from the unit. Here a two-mile stretch of uncoated pipe halts further extension of protection from this one unit. Cost per mile per year figured approximately $4.00. The 30 miles in Alabama has been brought up to 850 millivolts pipe-to-soil potential with 64 magnesium anodes installed in 16 groups of 4 each, at a total cost of $800.00. Calculated to last 15 years, this installation will cost approximately $1.75 per mile per year. On the remainder of the line, protection is going to be more difficult to obtain. It is anticipated, however, that protection will be needed only at local-

PIPELINE + UNIT — 5 VOLT SCALE

PIPELINE + RAILWAY — 25 VOLT SCALE

Figure 9—Twenty-four hour charts showing action of stray current drainage unit.

ized hot spots, river and stream crossings and other short-coated sections. Our experience to date and the remoteness of the line in most cases from any source of power has lead to plans for a thorough trial of galvanic anodes. In this connection, the use of aluminum anodes with a precast solid backfill appears to have merit for installation on river banks and in wet areas where installations using a slurry backfill would be difficult due to water filling or overflowing the hole (Figure 5).

Stray Current Drainage

In the Carolinas, strong stray current is encountered. Because of its fluctuating nature, it is not possible to bond directly to the railway system from which it emanates and some type of directional switch is needed. At the time we first became concerned with the problem there was no satasfactory unit for this purpose on the market.

The ideal unit would be rugged, permanent, self-actuated, positive in operation and require a very minimum of maintenance. After considerable thought, it was decided to try an assembly of copper oxide rectifier plates. A number of 24-hour recordings were made which indicated the average potential between the pipe and rail was about 5 volts, with short periods up to 25 volts. Flow of current through a low-resistant bond averaged 8 to 10 amperes, with short fluctuations up to 30 amperes. General Electric Company engineers were consulted. They advised that their 4⅜-inch by 5-inch copper oxide plate, which is rated at three amperes capacity in the forward direction, would in the reverse direction block four volts continuously and a much higher voltage for short periods.

Half-wave stacks were assembled using seven of these plates, to give 28 volts blockage; and ten stacks were connected in parallel to give 30 amperes capacity. This unit (Figure 6), designed for oil immersion, was just recently completed and a trial installation was made (Figure 7). Charts taken with recording voltmeters (Figures 8-9) indicate that the unit performed as anticipated, draining at times as high as 15 amperes and blocking at times as high as 15 volts. Having ample capacity, the characteristics of copper oxide plates are such that this unit should last indefinitely with no maintenance other than occasional painting. Actual cost of the unit was $175.00 including $125.00 for the stacks, $26.00 for other material and $24.00 for fabrication. Cost of installation is estimated at $75.00 including cable, for a total installed cost of $250.00.

Conclusions

The economical application of cathodic protection requires the careful selection of the proper equipment. Rectifiers, windmills, and galvanic anodes each being most satisfactory under certain conditions.

The success with magnesium anodes in low-resistant soil at a number of stations along Plantation Pipe Line has led to plans for their use at river crossings and along remote sections of the line where cathodic protection is desired. Oil-immersed copper oxide rectifier plates assembled in half-wave stacks can be used to form stray current drainage units which are efficient, permanent and inexpensive.

Discussion

*By C. W. Evans**

Some of the corrosion problems encountered on the Plantation Pipe Line system closely parallel problems encountered by many other corrosion engineers. High soil resistivity, protective coatings which vary widely, and stray currents all tend to make cathodic protection difficult. Mr. Nelson appears to have approached his problems in an intelligent, energetic manner, and by a logical sequence of trial and error to have arrived at the end result of protecting various structures.

He mentions that leaks have occurred in the control piping of the stations and also that the piping is bonded to extensive copper ground-beds. This immediately suggests that the control piping should be electrically insulated from the copper ground-bed to eliminate galvanic action which tends to protect the copper at the expense of the iron.

It is noted that rectifiers are being installed at several locations using magnesium bars for ground-beds. Although this deviates sharply from generally accepted practice and is certainly not recommended, Mr. Nelson was probably justified in doing it in this case because the magnesium bars were first installed for use as galvanic anodes. Later, when they failed to deliver sufficient current by reason of high soil resistivity, additional driving voltage was supplied by rectifiers. If coke ground-beds had been installed in the first place they would have been considerably less expensive and would have given much longer life. It is suggested that adequate preliminary field data and careful design engineering would have paid dividends in this case. While the economics of galvanic anodes are excellent under certain conditions, the experience of the writer has shown that in high-resistant soils, the higher driving voltage of rectifiers is almost always necessary.

Table II, as it stands, is quite misleading inasmuch as it compares the cost of installing 20 galvanic anodes with the cost of a 50-ampere rectifier. Total output capacity of the 20 magnesium anodes, assuming a ten-year life and 50 percent anode efficiency, will be about two amperes. Thus, the rectifier, which costs six times as much as the magnesium anodes, actually has 25 times the output capacity.

The copper oxide stack designed for controlling stray currents appears to have been very well designed. A paper describing results obtained after operating the unit for a year or two would be a valuable contribution.

* United Gas Pipe Line Co., Shreveport, La.

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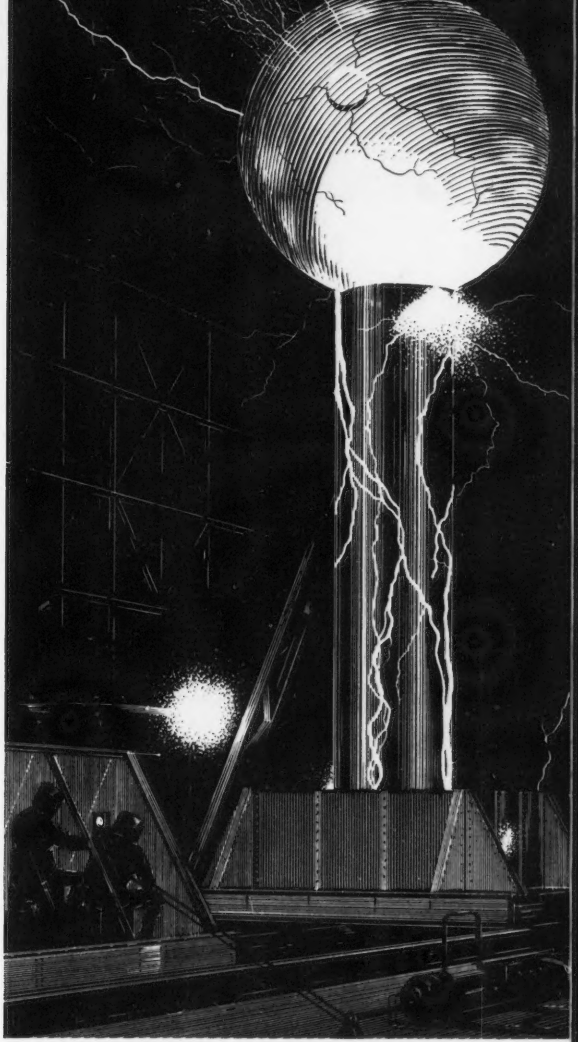


All-Corrosion Show Section

Hotel Jefferson, April 5-8

ST. LOUIS

MARKING ANOTHER YEAR OF PROGRESS IN CORROSION CONTROL

Ten Technical Symposia, Exhibition Feature 1948 NACE All-Corrosion Show

MARKING five years of organizational progress in their cooperative effort to reduce corrosion losses in all industry, the National Association of Corrosion Engineers will open the doors to their 1948 Conference and Exhibition Monday, April 5, at the Hotel Jefferson, St. Louis, Mo. The highly concentrated All-Corrosion program will extend through Thursday, April 8.

During the well-filled program, ten technical symposia on industrial corrosion problems will be held, new officers installed, NACE Awards presented, and plans furthered for continued expansion of Association activities and increased cooperation for exchange and dissemination of corrosion control data. The Corrosion Exhibition, scheduled concurrently with the Conference, will feature almost every known method to prevent Nature's never ceasing attempt to reclaim all metallic substance.

In line with the Association's policy to ever increase their scope of activities, two new symposia will be presented this year. These new symposia cover the subjects of Salt Water Corrosion and Protective Coatings for Metals. The addition of these two symposia increases to ten the number of technical sessions which will be held. Other scheduled meetings will cover industrial corrosion problems encountered in the Oil, Water, Chemical, Electrical, Communications, and General Industry, besides one dealing primarily with Cathodic Protection.

The papers to be presented during each symposium, are so divided as to cover the practical as well as theoretical aspects of corrosion control. Time has been allowed following presentation of each paper for discussions, several of which have been already arranged.

Aside from the technical aspect of the Show, an excellent entertainment program has been arranged for the membership at large and their guests, and ladies who will attend the Conference. This will take

Skyline View of Downtown St. Louis.

G. R. OLSON
President, NACE

F. L. LAQUE
Vice President, NACE

form of music and special attractions at the Annual Banquet, a Cocktail Hour through courtesy of Exhibitors, and a special program designed for the ladies.

While meetings of the Executive Committee and the Board of Directors will be held Sunday, April 4, the Conference officially opens Monday, April 5, with Registration scheduled to begin at 9:00 A. M. The Registration Booth will be located on the Mezzanine Floor of the hotel, in which area all functions of the All-Corrosion program will take place. The Exhibit Arena will open at 10:00 daily. Closing hour will be 6:30 P. M., except Monday and Wednesday, when the Arena will close at 5:30 P. M.

No technical session is scheduled the first day, the afternoon of which will be occupied with the General Assembly, to be followed by a business meeting for members.

Two concurrent technical sessions will be held Tuesday morning, with dual sessions scheduled both in the mornings and afternoons on Wednesday and Thursday.

Highlighting the Annual Banquet Wednesday evening, April 7, will be the introduction of the new officers and presentation of the Willis Rodney Whitney Award in the Science of Corrosion, and the Frank Newman Speller Award in Corrosion Engineering.

The General Conference and Exhibition Committee is headed this year by Fred L. Goldsby, Chicago Bridge and Iron Co., New York. Maynard H. Jackson, Hill, Hubbell & Company, Division of General Paint Corp., Northfield, Ill., is directing the activities of the Exhibit Committee, while Mars G. Fontana, Professor of Metallurgical Research, The Ohio State University, Columbus, is Chairman of the Technical Program Committee, which is arranging for papers and speakers at the various symposia: The tentative program for the NACE 1948 Conference and Exhibition follows:

PROGRAM *National Association o*

CONFERENCE, EXHIBITION APRIL 5-6

Monday, April 5

9:00 A.M.—Registration.
Mezzanine Floor.

10:00 A.M.—Formal Opening of Exhibition.
Exhibition Arena, Mezzanine Area.

2:00 P.M.—General Assembly.
Gold Room—Mezzanine Floor.
G. R. Olson, Presiding.

1. President's Report, G. R. Olson, United Gas Pipe Line Co., Shreveport, Louisiana.
2. The War on Waste—Corrosion Front, J. W. McAfee, President Union Electric Co., of Missouri, St. Louis, Mo.
3. NACE, And You, J. C. Stirling, Stanolind Pipe Line Co., Tulsa, Okla.

4:00 P.M.—Business Meeting—Members Only.
Gold Room—Mezzanine Floor.
F. L. LaQue, Presiding.

6:00 P.M.—Cocktail Hour, courtesy Manufacturers and Distributors, Gold Room—Mezzanine Floor.

Tuesday, April 6

OIL INDUSTRY SYMPOSIUM

Gold Room—Mezzanine Floor

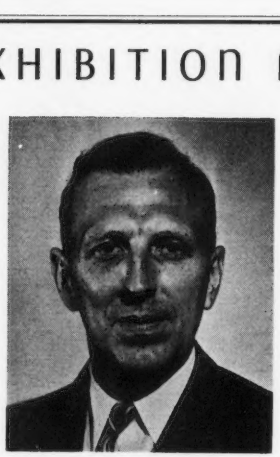
Chairman, Aaron Wachter, Shell Development Co., Emeryville, California.

9:00 A.M.—Effects of Hydrogen Generated by Corrosion of Steel, by M. H. Bartz and C. E. Rawlins, Phillips Petroleum Co., Bartlesville, Oklahoma.

9:40 A.M.—Action of Rust-Preventive Oils, by E. R. Barnum, R. G. Larsen and A. Wachter, Shell Development Co., Emeryville, California.

10:20 A.M.—Sour Crudes — Equipment Protection, by E. Q. Camp, Humble Oil and Refining Co., Baytown, Texas.

11:00 A.M.—Corrosion Problems in a Modern Fluid Catalytic Cracking and Fractionating Unit, by Nathan Schofer, Cities Service Refining Corp., Lake Charles, La.



F. L. GOLDSBY
General Committee Chairman

M. G. FONTA
Technical Program Chairman

Tuesday, April 6

WATER INDUSTRY SYMPOSIUM

Crystal Room—Mezzanine Floor

Chairman, A. H. Ullrich, Water Department, City of Austin, Texas.

9:00 A.M.—Corrosion Problems in Water Wells, by T. E. Larsen, Illinois State Water Survey, Urbana, Ill.

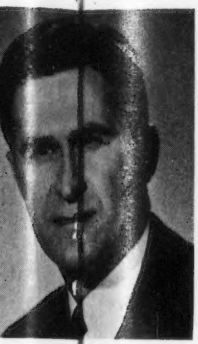
9:25 A.M.—Discussion by R. H. McLeod, Electro Rust-Proofing Corporation, Belleville, N. J., and general discussion.

9:45 A.M.—Corrosion Control Practices of Water Utilities, by L. H. Enslow, Editor, Water and Sewage Works, New York, N. Y.

10:25 A.M.—Extending the Life of an Old 60-inch Steel Pipeline by Cementing in Place, R. G. Counselman, Centriline Corp., New York, N. Y.

10:50 A.M.—Discussion by T. J. Skinker, Water Commissioner, St. Louis, Mo., and general discussion.

11:10 A.M.—A Simple Test Method for Evaluating Corrosion Inhibitors, by J. W. Ryznar, and Jerome Greene, National Aluminate Corporation, Chicago, Ill.



M. G. FONTANA
Technical Program Committee
Chairman

M. H. JACKSON
Exhibits Committee
Chairman

Wednesday, April 7

CHEMICAL INDUSTRY SYMPOSIUM

Gold Room—Mezzanine Floor

Chairman, W. C. Fernelius, Syracuse University, Syracuse, N. Y.

9:00 A.M.—Corrosion Problems in the Manufacture of Soda Ash by the Ammonia Soda Process, by Gustave Heinemann, Southern Alkali Corp., Corpus Christi, Texas.

9:40 A.M.—Application of Electron Diffraction Techniques to the Study of Corrosion Processes, by E. A. Gulbransen, Westinghouse Research Laboratories, East Pittsburgh, Pa.

10:20 A.M.—Resistance of Alloys to Corrosion During the Processing of Some Foods, by J. F. Mason, Jr., The International Nickel Co., Inc., New York, N. Y.

11:00 A.M.—Corrosion of Aluminum in Dilute Aqueous Solutions, by J. P. Howe, General Electric Co., Schenectady, N. Y.

Wednesday, April 7

ELECTRICAL INDUSTRY SYMPOSIUM

Crystal Room—Mezzanine Floor

Chairman, L. J. Gorman, Consolidated Edison Company, New York, N. Y.

9:00 A.M.—Corrosion of Underground Power Cable Sheaths, by L. F. Greve, Engineering Department, Commonwealth Edison Co., Chicago, Ill.

9:40 A.M.—Experience at Bagnell Dam to Prevent Corrosion of Underwater Steel and Iron, by Turner White, Jr., Union Electric Co. of Missouri, St. Louis.

10:20 A.M.—Corrosion from Flue Gases, by E. A. Rudulph, Union Electric Co. of Missouri, St. Louis.

11:00 A.M.—Discussion of Condenser Tube Corrosion, by F. R. Stauffacher, Southern California Edison Co., Los Angeles, Calif.

11:30 A.M.—Discussion of Bearing Corrosion in Turbo-Generators, by L. J. Gorman, Consolidated Edison Co., New York, N. Y.

CATHODIC PROTECTION SYMPOSIUM

Gold Room—Mezzanine Floor

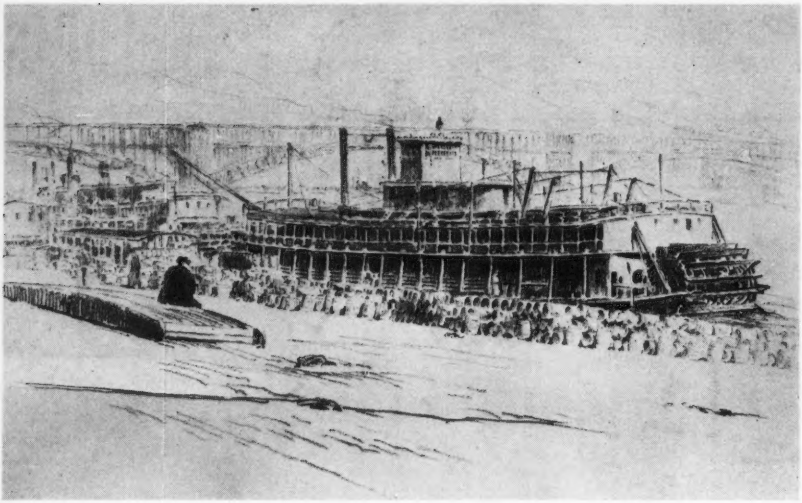
Chairman, R. A. Brannon, Humble Pipe Line Company, Houston, Texas.

2:00 P.M.—Twenty Years of Cathodic Protection in New Orleans, by R. J. Kuhn, New Orleans, La.

2:40 P.M.—Cathodic Protection Applied to Gas and Electric Utility Operations, by W. J. Schreiner, The Cincinnati Gas & Electric Co., Cincinnati, Ohio.

3:20 P.M.—Cathodic Protection of Casings in Loudon Pool, by S. P. Ewing and J. F. Bayhi, The Carter Oil Co., Tulsa, Okla.

4:00 P.M.—Cathodic Protection in Gas Distribution Systems, by F. B. Fry, Public Service Co., of Colorado, Denver.



A typical scene on the St. Louis levee.

Wednesday, April 7

PROTECTIVE COATINGS FOR METALS SYMPOSIUM

Crystal Room—Mezzanine Floor

hairman, George W. Seagren, Mellon Institute, Pittsburgh, Pa.

2:00 P.M.—Principles of Protecting Metals with Organic Coatings, by A. J. Eickhoff and William E. Shaw, National Lead Co., Research Laboratories, Brooklyn, N. Y.

2:40 P.M.—Preparation of Metal Surfaces for Organic Coating, by G. R. Hoover, American Rolling Mill Co., Middletown, Ohio.

3:20 P.M.—Building Organic Protective Coatings to Special Requirements, by K. G. Compton, Bell Telephone Laboratories, Inc., Murray Hill, N. J.

4:00 P.M.—Organic Linings for Chemical Equipment, by Kenneth Tator, Industrial Lining Engineers, Inc., Edgeworth, Pa.

Wednesday, April 7

ANNUAL NACE BANQUET

7:00 P. M.

Gold Room—Mezzanine Floor

G. R. Olson, Presiding.

T. F. P. Kelly, Master of Ceremonies.

1. Introduction of Officers and Directors.

2. Presentation of NACE Awards, by F. N. Speller, Chairman of the Awards Committee. Honored are Ulick R. Evans, who will receive the Willis Rodney Whitney Award in the Science of Corrosion, and John M. Pearson, who will be presented the Frank Newman Speller Award in Corrosion Engineering.

3. I Cover the Feature Front, Miss Beulah Schacht, Staff Columnist, St. Louis Globe-Democrat, St. Louis, Mo.

Thursday, April 8

GENERAL INDUSTRY SYMPOSIUM

Gold Room—Mezzanine Floor

Chairman, Ralph M. Hunter, The Dow Chemical Co., Midland, Mich.

9:00 A.M.—A Geographic Study of Deposits and Corrosion, by F. N. Alquist, The Dow Chemical Co., Midland, Mich.

9:40 A.M.—Punched Cards for Filing Corrosion Test Results, by Lorraine R. Voigt, The International Nickel Company, Inc., New York, N. Y.

10:20 A.M.—Behavior of Hydrogen in Steel During and After Immersion in Acid, by L. S. Darken and R. P. Smith, Research Laboratory, U. S. Steel Corporation, Kearny, N. J.

11:00 A.M.—Corrosion Problems in Boiler Feed Waters and Waters Used in Plant Cooling Systems, by S. T. Powell, and L. G. von Lossberg, Chemical Engineers, Baltimore, Maryland.

COMMUNICATIONS SYMPOSIUM

Crystal Room—Mezzanine Floor

Chairman, L. R. Routson, Western Union Telegraph Co., Chicago, Ill.

9:00 A.M.—Current Intensities of Soil Corrosion Cells, by E. D. Sunde, Bell Telephone Laboratories, New York, N. Y.

9:40 A.M.—A Cooperative Approach to Electrolysis Problems, by R. M. Lawall, American Telephone and Telegraph Co., Detroit, Mich.

10:20 A.M.—Prevention of Corrosion in Lead Sheathed Cables by Means of a Vulcanized Protective Covering, by B. B. Reinitz and N. A. Zamborsky, The Okonite - Callender Cable Co., Paterson, N. J.

11:35 A.M.—A Case of Corrosion Involving Cinders, by C. H. Thompson, New York Telephone Co., New York, N. Y.

Thursday, April 8

SALT WATER CORROSION SYMPOSIUM

Gold Room—Mezzanine Floor

Chairman, C. P. Larrabee, Research Laboratories, Carnegie-Illinois Steel Corp., Vandergrift, Pa.

2:00 P.M.—Salt Water Corrosion of Ships, by R. A. Pomfret and L. M. Mosher, Quincy Plant, Bethlehem Steel Corp., Shipbuilding Division, Quincy, Mass.

2:40 P.M.—Cathodic Protection of Steel in Sea Water Using Magnesium Anodes, by H. A. Humble, The Dow Chemical Co., Midland, Mich.

3:20 P.M.—Performance of Steam Condensers Aboard U. S. Naval Vessels, by H. E. Bethon, Bureau of Ships, Navy Department, Washington, D. C.

4:00 P.M.—Brine Corrosion in the Oil Industry, by H. T. Kennedy, Gulf Research and Development Co., Harmarville, Pa.

GAS INDUSTRY SYMPOSIUM

Crystal Room—Mezzanine Floor

Chairman, F. J. McElhatton, Panhandle Eastern Pipe Line Co., Kansas City, Mo.

2:00 P.M.—Fifteen Years Experience in Application of External Corrosion Mitigation Methods to a High Pressure Natural Gas Transmission Line, by N. K. Senatoroff, Southern Counties Gas Company of California, Los Angeles.

2:40 P.M.—Reference Electrodes: Design and Polarization Characteristics, by R. F. Hadley, F. A. Young and D. F. Van de Water, Susquehanna Pipe Line Company, Philadelphia, Pa.

3:20 P.M.—Present-Day Aspects of Condensate Well Corrosion, by H. E. Waldrip, Gulf Production Division, Gulf Oil Corporation, Houston, Texas.

4:00 P.M.—Analysis of NACE Condensate Well Corrosion Field Data, by V. V. Kendall, National Tube Co., Pittsburgh, Pa.

4:25 P.M.—Laboratory Determination of the Relative Corrosion Resistance of Metals Considered for Condensate Well Service, by C. K. Eilerts, Faye Greene, F. G. Archer, and L. M. Burman.

COMMITTEE MEETINGS

Board of Directors, First Meeting,
G. R. Olson, Presiding.

Board of Directors, Second Meeting,
F. L. LaQue, Presiding.

Executive Committee,
G. R. Olson, Presiding.

GENERAL

Abstract Committee,
L. R. Voigt, Chairman.

Advertising Committee,
J. J. Clancy, Chairman.

Committee on Relations With Other Technical Societies,
F. L. LaQue, Chairman.

Editorial Correspondents,
Ivy M. Parker, Chairman.

Exhibits Committee,
Maynard H. Jackson, Chairman.

General Conference Committee,
F. L. Goldsby, Chairman.

Local Arrangements Committee,
W. H. Keller, Chairman.

Membership Control Committee,
Tom L. Holcombe, Chairman.

Policy and Planning Committee,
H. M. Trueblood, Chairman.

Publication Committee,
Ivy M. Parker, Chairman.

Regional Management Committee,
George B. McComb, Chairman.

Technical Program Committee,
Mars G. Fontana, Chairman.

TECHNICAL

Technical Practices Committee,
R. B. Mears, Chairman.

Anodes for Use with Impressed Currents Committee,
Donald H. Bond, Chairman.

Condensate Well Corrosion Committee,
Walter F. Rogers, Chairman.

Corrosion Problems Involved in Handling Inland Waters, Committee on
V. V. Kendall, Chairman.

Corrosion Problems Involved in Processing and Handling Chemicals, Committee on
Mars G. Fontana, Chairman.

Galvanic Anodes for Cathodic Protection Committee,
M. C. Miller, Chairman.

Materials for Use at High Temperatures, Committee on
M. A. Scheil, Chairman.

Minimum Current Requirements for Cathodic Protection,
A. V. Smith, Chairman.

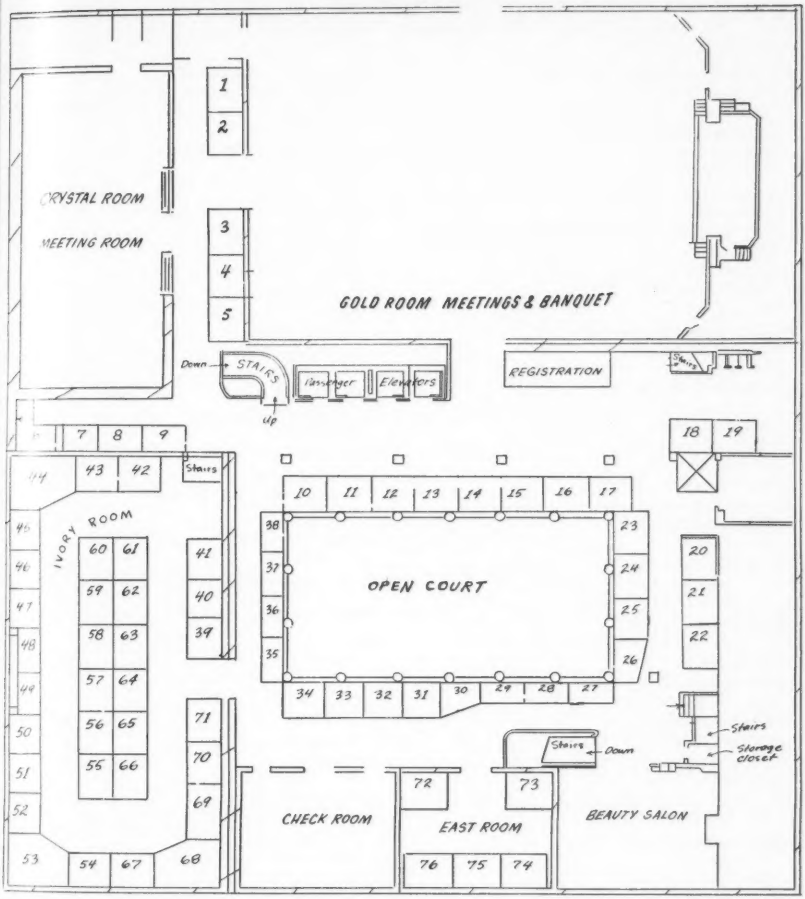
Prevention of Corrosion by Means of Inhibitors, Committee on
Aaron Wachter, Chairman.

Protective Coatings Committee,
Tom L. Holcombe, Chairman.

AMERICAN COORDINATING COMMITTEE ON CORROSION

Will Hold Luncheon Meeting in Conjunction with NACE Conference and Exhibition at 12:30 P. M., Tuesday, April 6, in Room 2, Second Floor of Hotel Jefferson

EXHIBITION ARENA, MEZZANINE AREA, HOTEL JEFFERSON



SHOW HOURS

The NACE All-Corrosion Exhibition at Hotel Jefferson, St. Louis, Mo., will open daily, Monday, April 5, through Thursday, April 8, at 10:00 A. M. Closing hours will be 6:30 P. M. except Monday and Wednesday, when the Arena will close at 5:30 P. M.

Exhibitors

Allied Chemical and Dye Corp.
The Barrett Division
40 Rector St., New York 6, N. Y.

Aluminum Company of America
Gulf Building
Pittsburgh 19, Pa.

American Pipe and Construction Co.
Amercoat Division
P. O. Box 3428, Terminal Annex
Los Angeles, Calif.

Apex Smelting Company
2537 W. Taylor St.
Chicago 12, Ill.

Aviation Chemicals Division
R. M. Hollingshead Corp.
Camden, N. J.

Cameron Iron Works, Inc.
P. O. Box 1212
Houston, Texas

Cathodic Servicing Co.,
1024 N. Olie St.
Oklahoma City, Okla.

Chicago Bridge and Iron Co.
332 S. Michigan Ave.
Chicago 4, Ill.

Corrosite Corporation
405 Lexington Ave.
New York, N. Y.

Crose, M. J., Mfg. Co.
2715 Dawson Rd.
Tulsa, Okla.

Crutcher-Rolfs-Cummings
Esperson Building
Houston, Texas

Dearborn Chemical Co.
310 S. Michigan Ave.
Chicago 4, Ill.

Dow Chemical Co., The
Midland, Mich.

Ebasco Services, Inc.
2 Rector St.
New York 6, N. Y.

Electric Railway Improvement Co., Inc.
2070 E. 61st Place
Cleveland 3, Ohio

Electro Rust-Proofing Corp.
P. O. Box 178
Newark 1, N. J.

Engineering Laboratories, Inc.
P. O. Box 349
Tulsa 1, Okla.

Equipment Manufacturers Co., Inc.
206 Oriskany St., East
Utica, N. Y.

Federal Telephone and Radio Corp.
100 Kingsland Rd.
Clifton, N. J.

Federated Metals Division
American Smelting and Refining Co.
120 Broadway
New York 5, N. Y.

Good-All Electric Mfg. Co.
112 W. 1st St.
Ogallala, Neb.

Hill, Hubbell & Co., Division of
General Paint Corp.
3091 Mayfield Rd.
Cleveland, Ohio

Hills-McCanna Co.
3025 N. Western Ave.
Chicago 18, Ill.

International Nickel Co., Inc., The
67 Wall St.
New York 5, N. Y.

Johns-Manville Sales Corp.
22 E. 40th St.
New York 16, N. Y.

Koppers Co., Inc.
Wailes Dove-Hermiston Dept.
Westfield, N. J.

Lebanon Steel Foundry
Lebanon, Pa.

Midwestern Engine & Equipment Co.
105 N. Boulder
Tulsa, Okla.

Miller, M. C.
2 Rector St.
New York 6, N. Y.

Minnesota Mining and Mfg. Co.
710 N. 12th St.
St. Louis, Mo.

Motorola, Inc.
4545 Augusta Blvd.
Chicago 51, Ill.

Natasco Co., The
P. O. Box 1318
Tulsa, Okla.

National Carbon Co., Inc.
30 E. 42nd St.
New York 17, N. Y.

National Lead Co.
111 Broadway
New York 6, N. Y.

Nelson Electric Mfg. Co.
217 N. Detroit
Tulsa, Okla.

Owens-Corning Fiberglas Corp.
Toledo 1, Ohio

Perrault Brothers
1130 N. Boston
Tulsa 6, Okla.

Philip Carey Mfg. Co., The
Lockland, Cincinnati 15, Ohio

Exhibitors (Continued)

Pipe Line Service Corp.
P. O. Box 218
Franklin Park, Ill.

Price, H. C., Company
P. O. Box 1111
Bartlesville, Okla.

Royston Laboratories, Inc.
Blawnox, Pa.

Saran Lined Pipe Co.
Stephenson Bldg.
Detroit, Mich.

Service Engineers, Inc.
First National Bank Bldg.
Fort Worth 2, Texas

Stearns, D. E.
P. O. Box 1234
Shreveport 90, La.

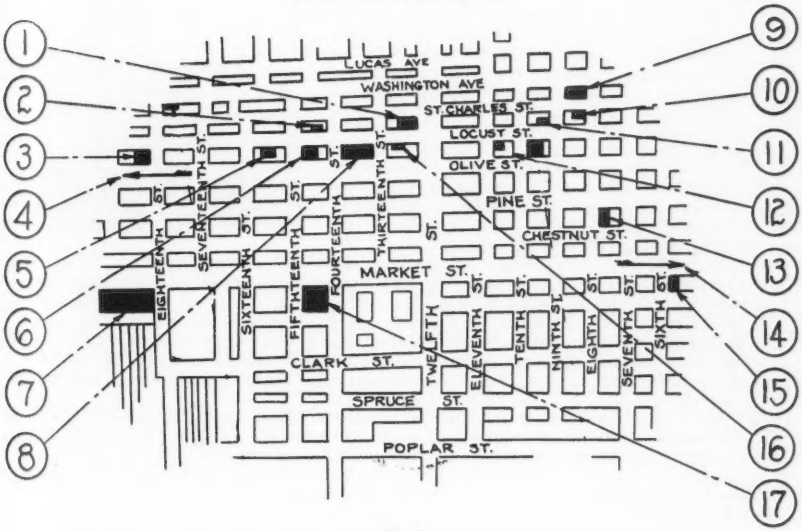
Tapecoat Company, The
1521-23 Lyons St.
Evanston, Ill.

United States Steel Corp.
436 Seventh Ave.
Pittsburgh 30, Pa.

Westinghouse Electric Corp.
P. O. Box 808
Pittsburgh 30, Pa.

Williamson T. D., Inc.
P. O. Box 4038
Tulsa 9, Okla.

DOWNTOWN ST. LOUIS



LEGEND

1. Hotel Jefferson
2. Y.W.C.A.
3. Hotel Claridge
4. To—Chase Hotel
   Coronado Hotel
   Melbourne Hotel
   Park Plaza Hotel
5. Y.M.C.A.
6. Hotel Warwick
7. Union Station
8. Public Library
9. Hotel Statler
10. Hotel Mayfair
11. Board of Education
12. Hotel DeSoto
13. Mark Twain Hotel
14. To Mississippi River
15. Hotel York
16. Bishop Tuttle Memorial Hall
17. Municipal Auditorium

A Message from Your Officers

This Month's Contributor

F. L. GOLDSBY, Director Representing Corporate Members, and Chairman 1948 NACE Conference and Exhibition General Committee

THE highlight of any association's activities is the Annual Convention or Conference. The Convention is a typically American institution and through them, possibly more than any other medium, greater contributions to the development and unity of the American Way of Life have been made.

Practically all organizations are set up on a democratic basis, and therefore must hold conventions. All association activity and power to carry on activity derives fundamentally from the members themselves. The annual conference is the instrument by which the membership of a society voices their wishes, and place authority in association officers, board of directors, trustees and others, to carry out these wishes, and to carry on for the benefit of the membership. You, as a member, can best enjoy the association by active participation in its affairs.

In addition to the purely business side of the annual meeting, its most important function is to serve as a medium for the exchange of ideas. This is particularly true for technical societies such as NACE. At the 1948 Conference at the Hotel Jefferson in St. Louis, members and guests can mingle free from prejudice, sectionalism and strained relationship of strong competition. All can mix in good fellowship for a full program of fine technical papers, social activities and a wonderful exhibit of the latest methods for the prevention and control of corrosion.

As general chairman of the 1948 Annual NACE Conference and Exhibit, I urge all members and their friends interested in corrosion problems to attend this meeting. The Technical Program Committee has arranged a full program of about 40 papers, covering latest developments and practices for the mitigation of corrosion. The Exhibition Hall will be filled with fine displays of products and demonstrations of methods for use in the control of corrosion. It will also serve as a meeting place where acquaintances can be renewed.

The Local Arrangements Committee has made provisions for many special events to supplement the technical program. An enjoyable program has been prepared for ladies.

So let's all meet at the Hotel Jefferson—April 5th to 8th. Bring your wives and let's all share in the activities and get acquainted with our fellow-workers and corrosion engineers.

Let our theme song be: "MEET ME IN ST. LOUIS — MEET ME AT THE CONFERENCE."

NACE News

NACE OFFICERS, DIRECTORS NOMINATED FOR 1948-49

During the January 12-13, 1948, meeting of the Board of Directors of the National Association of Corrosion Engineers, held in St. Louis, Mo., the Directors, acting all together as a Nominating Committee, nominated the following officers for 1948-49: F. L. LaQue, President; H. H. Anderson, Vice President; O. C. Mudd, Treasurer.

Mr. LaQue, presently Vice President of the Association, is in charge of the Corrosion Engineering Section, Research and Development Division of The International Nickel Company, Inc., New York, which company he joined shortly after receiving his Bachelor of Science degree in Chemical and Metallurgical Engineering from Queen's University, Kingston, Ontario, Canada, in 1927. After preliminary training in the research laboratory at Bayonne, N. J., and the mill at Huntington, W. Va., Mr. LaQue was assigned to work on corrosion-resistant alloys. He has continued in this field of activity until the present, with particular emphasis on the practical aspects of corrosion. He was instrumental in the founding of the "Marine Testing Laboratory," at Kure Beach, N. C., the largest of its type in the world. Mr. LaQue has been active in connection with matters related to corrosion in such organizations as the American Chemical Society, the Technical Association of the Pulp & Paper Industry, the American Society of Testing Materials, American Society of Metals, and the Electrochemical Society. He has served as chairman of the Gibson Island Corrosion Conference of the American Association for the Advancement of Science, and was chairman of the American Coordinating Committee on Corrosion, and has been an active member of NACE governing groups and committees.

Mr. Anderson, who if elected will vacate his unexpired term as Director Representing Corporate Membership, is Vice President and General Manager of the Shell Pipe Line Corporation, Houston, Texas. For the past year he has served as a Director of NACE, during which time he has done much to increase the number of Corporate memberships in the Association, and has given helpful advice on Association

affairs. He is greatly interested in the cooperative solution of corrosion problems, where more than one company, group or organization is involved. Professionally, Mr. Anderson is an electrical engineer and has been engaged in an engineering and executive capacity in the petroleum industry for the past 25 years. He is presently Chairman of the Correlating Committee on Cathodic Protection, a committee jointly sponsored by eleven nation-wide organizations for the purpose of inter-industry activity to publicize and improve procedures for handling problems arising from cathodic protection of industrial metallic structures.

Mr. Mudd, one of the first members of NACE, has been Treasurer of the Association since its founding in 1943. He was studying electrical engineering at Montana State College when World War I interrupted his education. He served in the armed forces from 1917-19, serving overseas duty in France. After the war, he was employed by the Montana Power Company at Billings in operation and construction departments. In 1925 he became superintendent of construction work for a firm near St. Louis. Work involved municipal improvements, levee building, and highway grading. He accepted a position at Shell Oil Company's Wood River, Ill., refinery in 1928, and was transferred to Shell Pipe Line Corporation in 1933, to assist in the first organized corrosion investigation on its system. He has continued in this work, and is now Chief Corrosion Engineer for Shell in Houston, Texas.

The Board of Directors also nominated three new directors for those offices which will become open in April. The nominations were as follows: D. E. Stearns, to succeed E. L. Rolfs as representative of the Associate Membership; L. J. Gorman, to succeed Arthur Smith, Jr., as representative of the Active Membership; and Vance N. Jenkins, as representative of Corporate Membership. Mr. Jenkins, if elected, would succeed himself, since he was recently named to fill the unexpired term of Glenn W. King, who resigned effective January 1. All terms are for a duration of three years.

Mr. Smith, who Mr. Gorman would succeed, was named to the Board last year to fill the vacancy created when Mr. LaQue resigned

Ulick R. Evans and John M. Pearson Honored

• Recommendations of the NACE Awards Committee having been approved by the Board of Directors, F. N. Speller, Chairman of the Committee, announced that Ulick R. Evans, Reader of Science, Cambridge University, Cambridge, England, and John M. Pearson, Director, Physical Division, Research and Development Division, Sun Oil Co., Upland, Pennsylvania, were selected to receive the two awards established last year by the Association. Dr. Evans will receive the Willis Rodney Whitney Award in the Science of Corrosion in recognition of his outstanding service in scientific study and experimental work and analyses of theory in connection with the corrosion of metals, while Dr. Pearson will be presented the Frank Newman Speller Award in Corrosion Engineering in recognition of his excellent work in the practical application of research in the field of corrosion control. Both awards bear the name of their first recipients. Dr. Speller was named chairman of the NACE Awards Committee shortly after his being signally honored to receive the award bearing his name.

as Director Representing Active Membership in order to accept the Vice Presidency of the Association.

Mr. Gorman graduated in 1909 from Clarkson College of Technology, Potsdam, N. Y., with a degree in electrical engineering, following which he was affiliated with the Test Section of General Electric Company, Schenectady, N. Y., for two years. He spent one year at Stevens Institute of Technology as an instructor in electrical engineering. Since 1912, he has been a member of the engineering staff of the Consolidated Edison Company of New York, and predecessor companies. In addition to a variety of important work, he has, since 1936, been engineer in Charge of Electrolysis and Corrosion, and underground cable and gas piping installations. For a number of years he was chairman of one of the project committees of the Joint Sub-Committee on Development and Research, Edison Electrical Institute and the Bell Telephone System, and has served in various capacities on several other committees dealing with corrosion problems.

Mr. Jenkins, who is Research Supervisor, The Union Oil Company of California, Wilmington, attended Southwestern University at Georgetown, Texas, and received an A. B. degree from Massachusetts Institute of Technology, Cambridge, Mass., in 1918. He taught chemistry at Emory University, Atlanta, Ga., from 1920 to 1921, at the same time doing graduate work in physics and math. He also did graduate work at the University of California, Berkeley, during 1920 and 1921. During the course of pursuing his education, Mr. Jenkins was employed as a research chemist by The Texas Company, Port Arthur, Texas, in 1919-1920 and rejoined the company in 1922. He served as Head of the Standardization Department, Technical Division, Texas Company in New York from 1926 to 1930, and in the latter year became affiliated with Union Oil, as a research chemist. In 1932 he was promoted to his present position.

Mr. Stearns has his own company in Shreveport, La., being the developer and designer of an electronic device for detection of holidays in pipelines. A graduate engineer, he was associated with the United Gas Pipe Line Company for a number of years. Among the first to join NACE as an individual member, his company has since become an Associate member. He has been a liberal advertiser in the NACE journal, CORROSION, since the first issue was published. He designed and created the NACE Emblem and presented it to the Association as a gift.

Appointment of a director to fill Mr. Anderson's unexpired term as Director representing the Corporate Membership will be held in abeyance pending his confirmation by the membership as Vice President. Announcement of nominations has been forwarded to all Members of the Association in accordance with the By-Laws. The new officers will be installed during the Annual Banquet, scheduled Wednesday evening, April 7, during the Conference and Exhibition of the Association, which will be held at the Hotel Jefferson, St. Louis.

ASSOCIATION BY-LAWS AMENDED

The Board of Directors of the National Association of Corrosion Engineers voted to adopt amendments to the By-Laws of the Association recommended by the Policy and Planning Committee, and submitted by H. M. Trueblood, chairman of the committee. These amendments, as extracted from the Policy and Planning Committee report of January 5, 1948, as approved by the Board of Directors of NACE during their January 12-13, 1948, meeting in St. Louis, Mo., follow:

ARTICLE V. The first paragraph of Section 3 is amended to read:

Section 3. A Regional Management Committee shall be appointed annually by the Board. It shall consist of at least five members who are Regional Directors, a Chairman, to be appointed by the Board of Directors, who shall not be a Regional Director and shall be an Active Member of the Association or the official representative of a Corporate or Associate Member, and a Vice-Chairman who shall be appointed by the Board of Directors. The Chairman shall be ex-officio a member of the Board.

ARTICLE VIII. Section 3 is amended to read:

Section 3. Such Regional Divisions, which shall consist only of members of this Association in good standing, shall elect their own officers and committees, and may make any rules for their government not inconsistent with the Articles or Organization and By-Laws of the Association. These rules must first be approved by the Board; and shall be so drawn that the following requirements are observed:

a. The fiscal year of each Regional Division shall be the calendar year, January 1 to December 31.

b. The administrative organization for a Regional Division shall be in the form of a Board of Trustees to consist of a chairman, a vice-chairman, and a secretary-treasurer of the Division, a regional director, and a fifth member. The officers of this Board of Trustees, consisting of the chairman, vice-chairman and secretary-treasurer, shall be identical respectively with corresponding officers of the Regional Division.

c. A quorum of a Regional Board of Trustees shall consist of any three of its members.

d. No dues shall be collected from members of Regional Divisions by the Regional Division organizations.

e. Where elections of regional officers and other members of Boards of Trustees are held at meetings of the regional membership, all members of record in the Regional Division shall be advised at least one week in advance concerning the meeting and the election to be conducted at it, and a quorum for such purposes shall be constituted by the members present at the meeting who are eligible to vote and who vote.

f. Local sections may be formed within Regional Divisions with the approval of the Regional Board of Trustees.

ARTICLE VIII. The last paragraph of Section 4 is amended to read:

Association funds in the hands of Regional Divisions shall not be accumulated by a Regional Division to an amount greater than that which it would be entitled to use in any calendar year. If at the end of one year the activities of the Regional Division have not required it to use the amount of money received from the Association, the Board may direct the Secretary and Treasurer to reduce the amount which the Regional Division will receive for use in the subsequent year to the sum needed to restore the funds to the amount entitled to be used in that year.

The Board of Directors also adopted amendments to the "Model" By-Laws for Regional Divisions proposed by the Policy and Planning Committee. The Model By-Laws, as amended during the January 12-13 NACE Board of Directors meeting, will be published in entirety in an early edition of CORROSION.

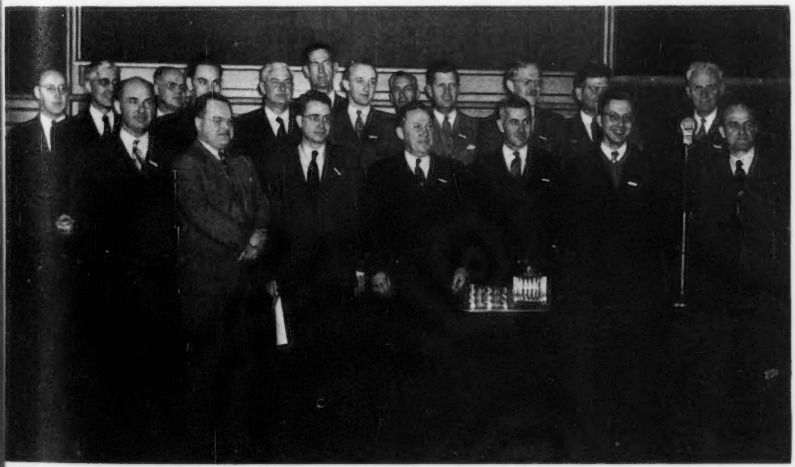
ACTIVITIES OF THE NACE COMMITTEE ON RELATIONS WITH OTHER TECHNICAL SOCIETIES DURING 1947

Following is a report on the activities of the NACE Committee on Relations with other Technical Societies, as made by F. L. LaQue, chairman of the committee:

"During 1947, the Committee on Relations with Other Technical Societies has pursued its objective of maintaining friendly relations with other organizations in its field and of cooperating with them to avoid duplication of effort.

"The principal activity was the organization and holding of the symposium on Cathodic Protection in cooperation with the Corrosion Division of the Electrochemical Society. This was held in Pittsburgh, Pa., on December 8 to 10, and was quite successful. Plans are being made to publish the combined symposium papers in book form.

"Another activity has been participation by means of representatives of the Technical Practices Committee, in the work of the Correlating Committee on Cathodic Protection. In this work the NACE has been associated with American Petroleum Institute; American Gas Association; American Public Works Association; International Municipal Signal Association; Bell System; American Association of Railroads; American Water Works Association; Edison Electric Insti-



A few of the 266 persons who attended the Cathodic Protection Symposium, jointly sponsored by the National Association of Corrosion Engineers and the Corrosion Division of Electrochemical Society which was held in Pittsburgh, Pa., in December, are pictured above. From left to right they are H. J. McDonald; R. B. Mears; R. A. Brannon; J. M. Pearson; T. P. May; R. Hadley; I. A. Denison; S. Skuldiner; C. W. Evans; E. D. Verink; M. C. Miller; R. B. Pope; F. J. LeFebvre; F. L. LaQue; E. A. Anderson; H. W. Wahlquist; J. M. Bialosky; L. J. Gorman; O. C. Mudd. Photograph courtesy Howard West, Standard Oil Development Co.

tute; United States Independent Telephone Association; and Western Union Telegraph Company.

"With the Natural Gasoline Association, the Technical Practices Committee has carried out extensive field corrosion tests which have added greatly to the knowledge of how metals and alloys withstand attack in corrosive condensate wells. Results of these tests will have considerable bearing on the choice of materials for this service.

"Arrangements were made to participate in the Pittsburgh International Conference on Surface Reactions, to be held in June, 1948. Cooperating organizations will be, Electrochemical Society; American Chemical Society; American Society for Metals; Pittsburgh Physical Society; National Association of Corrosion Engineers and University Conference on Corrosion.

"NACE will also participate in the Cleveland Corrosion Conference, to be held in the fall of 1948. The associated organizations will be: American Chemical Society; American Institute of Chemical Engineers and Electrochemical Society.

"In response to an invitation, NACE was represented by authors who contributed papers to the International Congress of Corrosion, held in Paris, France, and sponsored by The Societe Francaise de Metallurgie and the Commission Technique des Etats et Proprietes de Surface des Metaux.

"Arrangements were made with the Electrochemical Society, through the Publication Committee, for republication of technical papers presented before that society.

"This committee plans to continue the efforts indicated by its title and hopes to expand its work toward coordinating activities in the field of corrosion."

PERSONALS

R. S. Farmer has been named Assistant Sales Manager for the Cameron Iron Works, Houston, Texas. Mr. Farmer has been in the oil tool supply and manufacturing industry of the Gulf Coast and Mid-Continent for the past 10 years. He joined Cameron's sales staff in 1942, working in Houston and later in the Corpus Christi area. In 1944, he was sent to Tulsa as Mid-Continent Division Manager, and recently promoted to his present position and returned to Houston. **R. W. Gustine,** formerly Cameron sales representative in Shreveport, La., has been transferred to Tulsa to succeed Mr. Farmer.

Those in this country and abroad interested in the field of Industrial Standardization will regret to learn of **P. G. Agnew's** retirement as Administrative Head of the American Standards Association. For many years. Mr. Agnew has devoted his entire time to the development of the American Standards Association and the standardization which it has accomplished. Largely through his foresight and efforts, those concerned with industrial standards may now speak in the same terms or units, the lack of which in the past has often led to confusion and misunderstandings in the industrial

field. Mr. Agnew's retirement took effect January 1 of this year. He is succeeded by **Admiral George Hussey,** Jr., USN (Ret.) who was wartime Chief of the Navy's Bureau of Ordnance. **Cyril Ainsworth,** who has established a high reputation during the years in which he has served as Technical Director and Assistant Secretary of the ASA, will continue in those offices with added responsibilities.

Wm. E. Huddleston and **Earl O. Owens,** of the Huddleston Engineering Co., Bartlesville, Okla., recently returned from Mexico City, where they conducted corrosion surveys and performed consulting work in connection with pipeline corrosion.

Earl J. Gorgis, graduate of Northwestern Commerce School, has been appointed Advertising Manager for the Dearborn Chemical Company, a Chicago chemical company specializing in boiler water treatment and rust preventives for railroad, marine, and industrial use. Mr. Gorgis was formerly associated with Aubrey, Moore and Wallace, the Honolulu *Advertiser* in Hawaii, Wade Advertising Agency, and most recently in the advertising department of the General Electric X-Ray Corp.

Wayne E. Broyles has joined the sales staff of Brance-Krachy Co., Inc., Houston, Texas, distributors of various oil field equipment. Mr. Broyles, formerly with The Texas Pipe Line Co., of the same city, will handle the sales of rectifiers for cathodic protection.

Walter E. Remmers has been elected President of Electro Metallurgical Company, it was announced by William J. Priestley, Chairman of the Board. Mr. Remmers was also elected President of Electro Metallurgical Company of Canada, Ltd., and other associated metallurgical units of the Union Carbide and Carbon Company. Mr. Remmers has been Vice President and Director of Electro Metallurgical Co. since 1945. He is a graduate of the Missouri School of Mines and Metallurgy, and took post graduate work in metallurgy at the University of Michigan. He has been associated with various metallurgical units of Union Carbide since 1936.

Carl E. Schmitz was promoted effective January 1 to Vice President and Director of Engineering, Crane Packing Company, Chicago, Ill. He was formerly chief engineer for the Company.

St. Louis Section Petitions

• Members of the National Association of Corrosion Engineers who reside in the St. Louis area, met February 9, 1948, in that Missouri city and voted to petition the North Central Regional Division of the Association, for recognition as a Local Section, to be known as the Greater St. Louis Section; and with officers as follow:

Chairman—W. H. Keller, Johns-Manville Sales Corp., St. Louis, Mo. Vice Chairman—Otto H. Fenner, Monsanto Chemical Co., St. Louis, Mo. Recording Secretary-Treasurer—Wm. A. Heideman, Socony-Vacuum Oil Co., East St. Louis, Ill. Corresponding Secretary—W. E. Gross, Tretolite Co., Webster Groves, Mo.

CORRECTION

In the NACE Membership Roster which appeared in the January edition of Corrosion (Vol. 4, No. 1, 1948) James J. Curran should be shown as associated with the Walworth Company, Greensburg, Pa., and Van W. Ratcliff as associated with the Rufnek Chemical Co., Houston, Texas.

EQUIPMENT CORROSION?

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Typical Chemical Industry Problems

Equipment To Be Coated	*Characteristics Of Exposures*	*Coating Recommended*
LABORATORY EQUIPMENT Table Tops, Fume Hoods and Ducts, Equipment, Etc.	Corrosion caused by a wide variety of chemicals, fumes and condensation.	AMERCOAT No. 33 recommended for table tops, fume hoods, ducts, lab equipment and concrete floors. Provides an attractive abrasion resistant finish that will resist most chemicals and solvents.
PIPE Steel and Concrete	Corrosion of interior of pipe caused by chemicals, food products, sewage, sour crude; also by electrolytic action. Contamination of contained product by iron or calcium pick-up. Exterior of pipe subject to chemical and electrolytic corrosion.	For maximum resistance to severe conditions, AMERCOAT Plastic Lined Pipe is recommended. For sewage, petroleum, food products, and milder chemicals, AMERCOAT No. 23, 44 or 55 are used. Exterior of piping subject to corrosive chemicals, fumes, and soil corrosion. AMERCOAT No. 33 provides outstanding protection.
TANKS AND TANK CARS	Corrosion of interior caused by acids, salts, alkalies, petroleum products, and organic chemicals. Contamination of contained product by contact with iron. Vapor space corrosion. Varying temperatures. Corrosion of exterior caused by weathering, chemical fumes and spillage of contents of tank.	Interior—AMERCOAT No. 23 is a general purpose lining material for concrete and metal tanks for both chemicals and food products. AMERCOAT No. 44 is designed for concentrated acids and salts; AMERCOAT Nos. 31 and 55 for concentrated alkalies and salts at elevated temperatures. Write for recommendation on your specific problem. Exterior—AMERCOAT No. 33 is recommended for maximum resistance to weathering, chemical fumes, and spillage.
FLOORS WALLS, CEILINGS, STRUCTURAL STEEL	Spillage and fumes from corrosive chemicals. Abrasion on floors from foot traffic. Mold and fungus growth. Weathering on exterior surfaces.	AMERCOAT No. 33 recommended for concrete floors and structural steel. Excellent abrasion resistance—unaffected by acids, oils, and cleaning compounds. AMERCOAT No. 88 recommended for masonry ceilings and walls—interior and exterior. Odorless during and after application. Weatherproof and waterproof. Resists bacteria, mold and fungus growths. AMERCOAT has excellent adhesion to both concrete and metal. Available in 14 colors.
PROCESSING EQUIPMENT Clarifiers, Filters, Blowers, Ducts, Pumps, Conveyors, Scrubbers, Etc.	Corrosion due to acids, salts and alkalies; spillage, fumes and moisture condensation.	AMERCOAT No. 33 recommended for most exterior surfaces of process equipment at temperatures up to 150° F. AMERCOAT No. 61 recommended for stacks and other hot surfaces at temperatures to 600° F. Write for recommendations for lining process equipment.

Free Corrosion Manual

Causes of corrosion and how to prevent it are fully covered in this booklet as indicated by the actual excerpts shown above. It also gives full descriptions of all types of AMERCOAT and methods of application to meet most every condition.

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COMPLETE SURFACE PROTECTION

The control of corrosion is directly dependent upon the efficiency of a protective coating. No single formula can be versatile enough to provide maximum surface protection under all conditions without compromising on some desirable quality. For this reason, AMERCOAT offers a variety of coatings, each designed to meet important requirements to control corrosion in industry.

There are AMERCOAT Coatings for a full range of uses—from general purpose coatings for maintenance to specialized coatings for surfaces subject to constant immersion, highly corrosive chemicals and excessive temperatures. Write for the AMERCOAT Corrosion Manual and complete information on the uses of AMERCOAT. *Please specify your industry. .*

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GENERAL INTEREST

Members of the newly organized San Francisco Bay Area of the Western Region of NACE held a successful meeting February 3 in Oakland, Calif. Edwin W. Barbee, of the San Francisco Water Department, spoke on the subject, "Corrosion Tuberculation Studies With San Francisco Water," and M. J. Gigy of the Cargocaire Engineering Corporation, presented a paper entitled, "Corrosion Prevention by Dehumidification."

The **North Texas** Section of the South Central Regional Division of NACE met January 21 in Fort Worth, Texas. O. C. Mudd, Senior Corrosion Engineer for Shell Pipe Line Corporation, and Treasurer of the parent Association, held the interest of an audience of 40 corrosion engineers with a talk on the economics of corrosion control. Mr. Mudd also pointed out that the corrosion research of the Association has been so valuable that the British, Australian, New Zealand and even the Russian governments have sought details of the results.

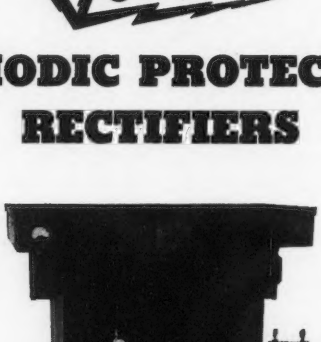
Bibliography Soon Ready

• A contract covering printing and binding of the Bibliography of Corrosion Literature for 1945, prepared by Hugh J. McDonald, James T. Waber and Robert D. Misch, has been let by NACE to Foote and Davies, printers in Atlanta, Georgia. It is expected that this comprehensive survey of corrosion literature will be off the presses and available for distribution April 1, this year.

The Committee on Anodes for Use With Impressed Current met January 31, 1948, in Houston, Texas, for purpose of detailing a procedure for collecting and recording test result data, according to Donald H. Bond, The Texas Pipe Line Co., Chairman of the Committee. The plan adopted calls for periodic inspections at all test sites, with reports going to the Chairman and J. P. Oliver. Mr. Oliver will record all data as received, and draft progress reports, subject to approval by the entire committee, for presentation at specified times. The first report is planned to be made during the NACE Conference in St. Louis, Mo., in April. All activities of the Committee will clear through the Chairman, to assure that proper coordination is attained, and a complete file of test results is maintained and available. The Committee has made excellent progress since its formation a little more than a year ago, with all test installations made or in the process of installation at the moment. Any further test installation requirements will be determined by the results obtained from present installations, or as may be decided by the Committee. The original program and scope of the Committee was established in earlier reports from the Committee, which were published in the June and July, 1947, editions of CORROSION.

GOOD-ALL

CATHODIC PROTECTION RECTIFIERS



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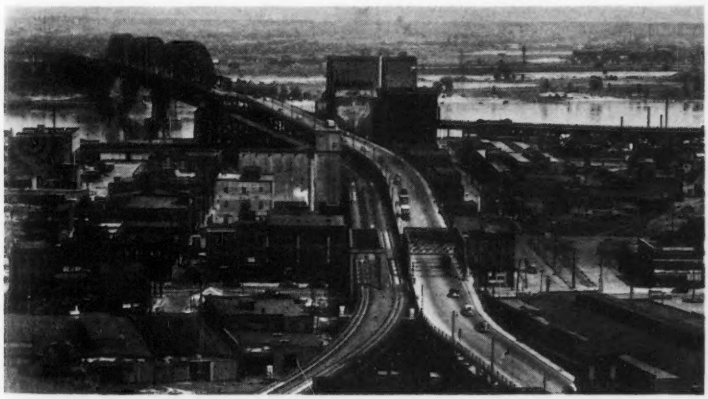
NEW PRODUCTS, MATERIALS AND SERVICES

A method of welding said to greatly simplify the problem of permanently attaching anode leads to pipelines, has been developed by The Electric Railway Improvement Co., 2070 East 61st Place, Cleveland 3, Ohio. The method employs the thermit process, which consists of the use of granular metals—principally aluminum and copper oxides—to produce molten metal, and to direct this metal against the object to be welded. The apparatus and mechanics of operation are said to be so simple that any workman can procure welds more surely than obtained by gas or electric welding. Cost of installing anode leads by this method is claimed considerably less than that of orthodox methods. A descriptive booklet is available by writing the manufacturer.

A new vinyl coating is announced by the Amercoat Division of the American Pipe and Construction Co., P. O. Box 3428, Terminal Annex, Los Angeles 54, Calif. The coating, called Amercoat 88, is a pigmented vinyl resin dispersed in water, and because of this has no unpleasant odor, either during or after application. The coating is said to be capable of resisting most dilute acids, and be unaffected by alkaline cleaning compounds normally employed as detergents. It is resistant to aliphatic alcohols and most aliphatic petroleum hydrocarbons. Waterproof and weatherproof, it is unaffected by continuous exposure to all animal and vegetable oils; will not support growth of bacteria, mold and fungi. Possessing a higher solid content than conventional vinyl



Members of NACE who reside in the East and motor to the April Conference and Exhibition will more than likely enter St. Louis via the MacArthur Bridge, shown above, crossing the Mississippi River.

coatings, it produces a thicker coating with fewer coats, providing greater coverage and better sealing action. It can be applied by brush or spray, and air dries without baking, and does not sag or run on vertical walls, and levels well. It can be applied over concrete, masonry, or wood surfaces, and will not soften or lift old paint. Detailed information can be obtained from the manufacturer.

Increasing application of aluminum conduit for the many electrification projects of Latin American countries has been reported by the Aluminum Import Corporation, 620 Fifth Avenue, New York 20, N. Y. In recent months this company has received orders totaling approximately 2 million pounds. Barbados, Bolivia, Colombia, Jamaica, Mexico, Panama, and Peru are among the countries where important quantities are on order. Aluminum Import Corp. is the Western Hemisphere distributor for all products of the Aluminum Co. of Canada, Ltd., including alumium conduit, which is marketed under the trade name of Alconduit. The company claims several advantages for this product in electrical use, among them being corrosion resistance and high electrical conductivity. Literature on this aluminum conduit can be obtained from the distributor.

Two new anti-corrosive coatings which will air-dry without baking have been announced under the trade name "Zincilate," by Industrial Metal Protectives, Inc., Dayton 2, Ohio. It is claimed by the manufacturer that accelerated laboratory tests indicate a 20-year corrosion protection life for the coatings, which are reported so flexible that sheets, pipe forms, etc., to which applied can be bent double without rupturing. Adaptable to production line methods of dipping, spraying, brushing, or roller coating, these coatings have found application for air conditioning equipment, bakery equipment, automotive parts and assemblies, valves, sheets, pipe, screen and other products, and can also be used for maintenance and repair of existing structures.

Charles Hardy, Inc., 420 Lexington Ave., New York 17, N. Y., announced availability of 18-8 stainless steel paste for purpose of obtaining corrosion-resistant surfaces. Performance tests indicate that in the presence of strong concentrations of nitric acid, sulfuric acid, and hydrofluroic acid fumes, exhaust fan blades coated with this paste survived six months as compared with two weeks where other metallic coatings were used. Test panels with a single stainless coating withstood more than 200 hours exposure in salt-spray. Almost any clear lacquer varnish, or bronzing fluid may be employed as a vehicle, with normal mixing requirement being approximately two pounds of paste to the gallon of vehicle. It can be applied either by brush or spray. Detailed information is available from the distributor.

Stalpic Coating Corporation, 1128 West Armitage Ave., Chicago 14, Ill., has available technical literature pertaining to the phenolic coating bearing the Company's name. It is obtainable free upon request.

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Plastelite Ring Gaskets

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- ✓ CORROSION PROOF
- ✓ RUST PROOF
- ✓ ACID AND ALKALI RESISTANT
- ✓ HIGH DIELECTRIC STRENGTH
- ✓ HYDROCARBON RESISTANT
- ✓ FIT ANY API FLANGE
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- ✓ INEXPENSIVE

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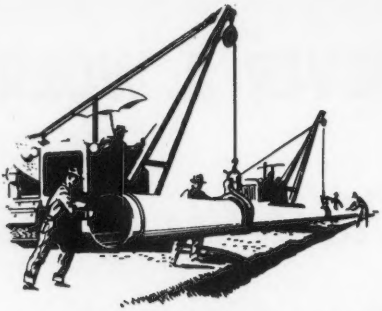
SERVICE ENGINEERS, INC.

FIRST NATIONAL BANK BLDG. FORT WORTH, TEXAS

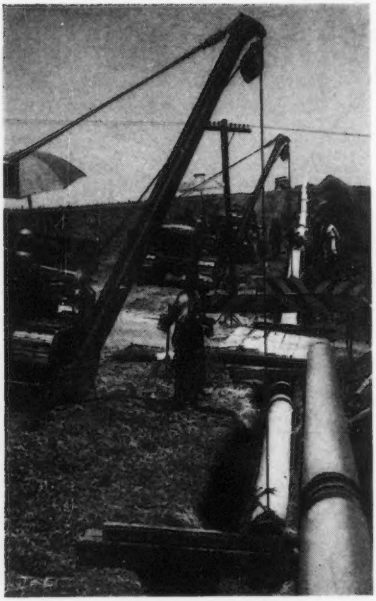
Permanent Pipe Protection



SOMASTIC

REG. U. S. PAT. OFFICE

PIPE COATING



EIGHTEEN YEARS of complete protection prove the staying power of SOMASTIC Pipe Coating. The permanence of this treatment introduces important economies:

— eliminates costly corrosion damage.

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Applied to pipe or operating pipe lines, at prices that show the owner an attractive return.

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SOMASTIC DIVISION
BARTLESVILLE, Oklahoma
—in the 37 States east of the Rocky Mountains

Corrosion Abstracts

ATMOSPHERIC CORROSION

Materials and Finishes for Tropical Service. C. D. COOK AND C. MERRITT JR., Gen. Elec. Mat. Meth. **25,** No. 1, 77-80 (1947) May.

Results of humidity and salt spray tests on cold rolled steel, stainless steel type 416, machined, type 430 machined and punched and drawn, and type 347, wrought aluminum, aluminum castings, yellow brass-copper, silicon bronze and beryllium-copper, zinc die cast, ASTMB 86-43 alloy No. 23, and magnesium die cast with various types of surface finishes are tabulated. Results obtained while developing satisfactory finishes for a variety of specific parts or subassemblies for electrical instruments to be used under tropical conditions.

BEARING CORROSION

Corrosion Failure in Diesel Engines — Bearing Materials — Rust Preventives and Corrosion Inhibitors. I. C. DE MARTONFALVY, Mech. World, **120,** No. 3123, 531-533 (1946). J. Inst. of Metals & Metall. Abs., **14,** 105 (1947) Mar.

Reviews the compositions and properties of modern diesel engine bearing materials, discusses the development of preservative lubricants and rust preventives, and considers the chemistry of corrosion inhibitors. —INCO.

COATINGS

Electron Diffraction Study of Oxide Films Formed on Molybdenum, Tungsten and Alloys of Molybdenum, Tungsten and Nickel. J. W. HICKMAN AND E. A. GULBRANSEN, Metals Technol., **14,** 17 (1947) Apr.

Following a survey of the literature, results of a study of the following problems are presented: existence diagrams of the oxides occurring on molybdenum and tungsten; existence diagrams of the oxides occurring on the alloys 80% molybdenum-20% tungsten, 93% molybdenum-7% nickel, 93% tungsten-7% nickel; and effects of heating and cooling the oxides that form on these metals and alloys. 22 ref.—BLR.

Electrical Properties of Paint Films on Metals. F. WORMWELL AND D. M. BRASHER, Nature, **159,** 678-679 (1947) May 17.

Results obtained for several paint systems show that there is a characteristic fall in potential during the first few hours. Afer an inervening period of somewhat fluctuating potential there is a rise to a maximum with a final decline. Apparent ohmic resistance and apparent capacity of paint film were next investigated. Capacity changes are shown to be roughly parallel to the approximate area covered with rust.—BLR.

CATHODIC PROTECTION

Novel Groundbed for Cathodic Protection. T. R. STATHAM, Magnolia Pipe Line Co., Petro. Eng. **18,** No. 7, 53-4 (1947) April.

A continuous cathodic protection system is described using makeshift materials installed in wartime to combat excessive leakage in Magnolia Petroleum Corp. pipelines transversing a highly corrosive soil. Hand insulated damaged steel drill cable was used as underground connections from rectifiers to pipelines to ground bed. The ground bed consisted of 20 foot joints of junk pipe welded to the cable. Rectifiers of 8 volts, 20 amperes output of current of 1.03 milliamperes per square foot of pipe surface. Relevant corrosion and engineering data are given graphically.

CHEMICAL CORROSION

Selecting Chemical Pumps. C. A. RICHARDSON, Allis-Chalmers Manufacturing Co., Chem. Eng. Prog., **1,** No. 2, 17-20 (1947) Feb.

The more important construction details and operating factors that should be considered when choosing chemical pumps, particularly where both corrosive and abrasive liquids are to handled are discussed. Pump parts subject to corrosion are discussed. The casing volute, impeller and wear plate, are subject to the most extreme wear and have the shortest life. Use of stainless steel in impellers is mentioned. The importance of the stuffing box with pumps handling corrosive solution is stressed.—INCO.

Sulfuric Acid Concentration—A Summary. Editorial Staff Report, Chem. Inds., **60,** No. 1, 50-52, 53 (1947) Jan.

Concentrators are usually of 14 silicon iron. Hastelloy D is desirable at high temperatures, because it is less brittle, but it is also less corrosion resistant. Tantalum is undergoing tests at present for this application. Concentrator is shown.—INCO.

Regularities in the Action of Organic Acids. (In Russian.) V. D. IAKHONTOV, J. Applied Chem. (USSR), **19,** No. 8, 761-772 (1946).

An investigation of the actions of a number of organic acids on steel, lead, tin, copper, and aluminum resulted in the observation of certain regularities in their behavior, especially in connection with dissociation constants and concentration of acids, temperatures, and times of action. Results are tabulated and charted.—BLR.

"Chemico" Drum-Type Sulfuric Acid Concentrator. J. H. BERGER & A. J. GLOSTER, Chem. Constr. Corp., Chem. Eng. Prog., **43,** No. 5, 225-236 (1947) May.

Description of design, operation and materials of construction. Steel acid cooling coils are standard. Stainless Type 304 increased life of coils slightly under normal conditions, but corroded more rapidly than steel with under 93% acid. An Ordnance Works cooler design uses an element consisting of cast iron hairpin tubes, service-proved, and sure to be used for strong acid installations of the future. Corrosion by residual acid from nitration pro-

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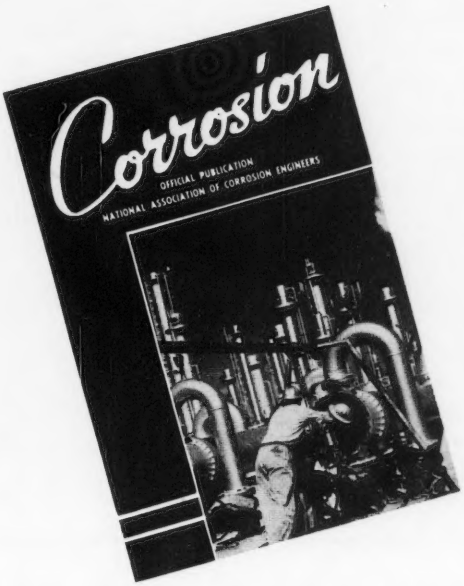

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cesses is reported in precipitators, where excess fuming was found to be the usual thing. Tube precipitators must be utilized. Flow diagram shows the "Chemico" drum-type concentration process and equipment.—INCO.

Wood vs. Corrosion. S. E. CHANEY, Corros. & Mat. Prot., **4**, No. 1, 6-11 (1947) Jan.-Feb.

An account of the use of wood tanks and wood pipes for carrying various corrosive materials.—BNF.

Acetic Acid and Chlorine vs. Materials of Chemical Plant Construction. Chem. Eng. **54**, 241-242 (1947) May.

Series includes articles on Haveg (a plastic material); stainless steel; miscellaneous resinous coatings; and lead.—BLR.

Hydrogen Peroxide. Structural Materials, Manufacture and Uses. J. S. REICHERT & R. H. PETE, Chem. Eng., **54**, 213-214+ (1947) Apr.

Summary discusses the fitness of various materials from the standpoint of corrosion resistance and activity as catalyzers of peroxide decomposition. Stabilizers are suggested for certain cases. Also describes manufacturing methods and applications.—BLR.

Mechanism of the Sulfide Corrosion of Iron. (In Russian.) P. V. GELD & O. A. ESSIN, J. Applied Chem. (USSR), **19**, No. 7, 678-683 (1946).

Comparison between experimental data for sulfide and for oxide corrosion of iron revealed certain simi-

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larities. The main difference seems to be that the concentration of components in the lattice structure of the iron-sulfur system varies over a larger range than in the iron-oxygen system.—BLR.

Use of Silver-Silver Chloride Reference Electrodes in Dilute Solutions. P. T. GILBERT, Faraday Soc. Preprint, 5 pp. (1947) April.

A short account is given of the use in corrosion work of silver/silver-chloride reference electrodes in solutions containing as little as 10 ppm chloride, and at temperatures up to 85° C. The problem of the interpretation of potential measurements made at different temperatures is discussed.—BNF.

Alloying Steels for Corrosion Resistance to Gas Condensate Fluids. K. EILERTS & F. O. GREENE, (Bur. Mines) Paper, NACE, Chicago (4/7-10/47); abs., Oil Weekly, **125,** No. 7, 36 (1947) April 14.

Laboratory tests were run to select the most effective metal to be subjected to actual field tests in the attempt to minimize corrosion losses in high-pressure, high-velocity flow in gas condensate well equipment. Results of tests on steel coupons exposed for 1, 7, 28, and 70 days to the action of carbonic acid, propionic acid, and phenol indicate that in carbonic acid, steel containing less than 8.6% nickel is no more effective than carbon steel, while for higher nickel content the effective corrosion resistance increases rap-

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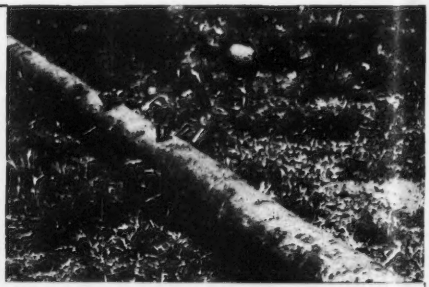

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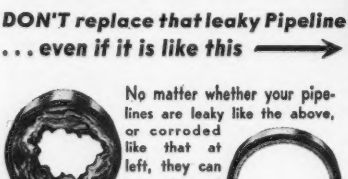

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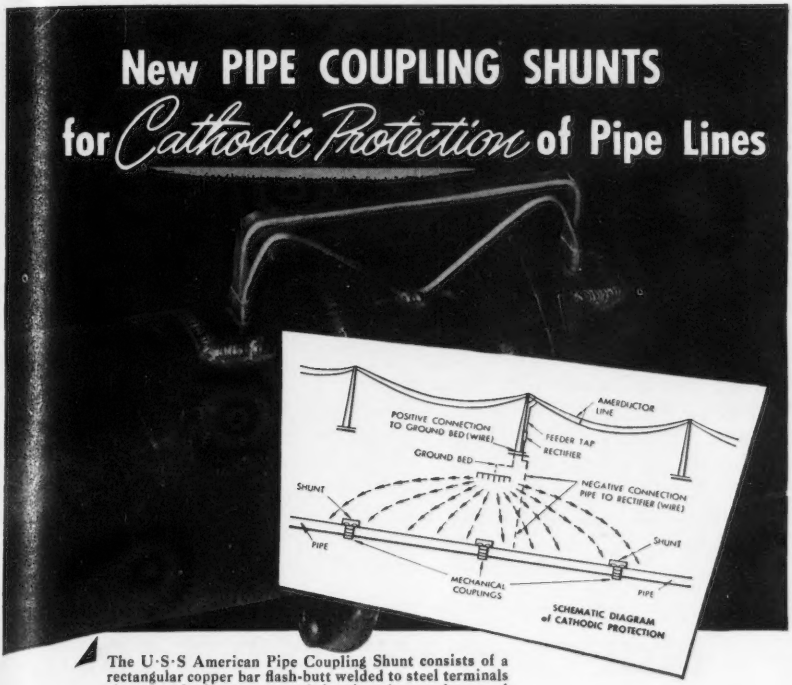

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idly, and that less than 5% chromium content confers no added corrosion resistance. Carbonic acid was most corrosive and phenol least corrosive of the three reagents used. With each of the reagents there was correlation between the effectiveness of the film of corrosion products in slowing down metal loss, as shown by the tests of 28 and 70 days duration against initial loss on the short-time tests.

Gas-Condensate Reservoir Engineering, Part 3. Equilibrium Factors, Hydrates, and Corrosion. C. K. EILERTS, (Bur. of Mines) Oil & Gas J., **45,** No. 41, 100 (1947) Feb. 15.

Part of report on studies of gas-condensate systems carried out by the Bureau of Mines in cooperation with the A. G. A. The internal corrosion of equipment is closely related to properties of the flowing fluid. The occurrence of the liquid phase of water in the stream entering the well bore, flowing to the surface through tubing or casing, and passing through Christmas-tree fittings to collecting lines on surface has bearing on probable location of corrosive attack. Equipment and method used by the Bureau of Mines for measuring the liquid-gas ratios are briefly described, and results presented. Experience gained in injecting aqueous solutions of inhibitors into wells indicates that fluid entering wells from reservoirs in which there has been some decline of pressure may be undersaturated with respect to water at formation pres-

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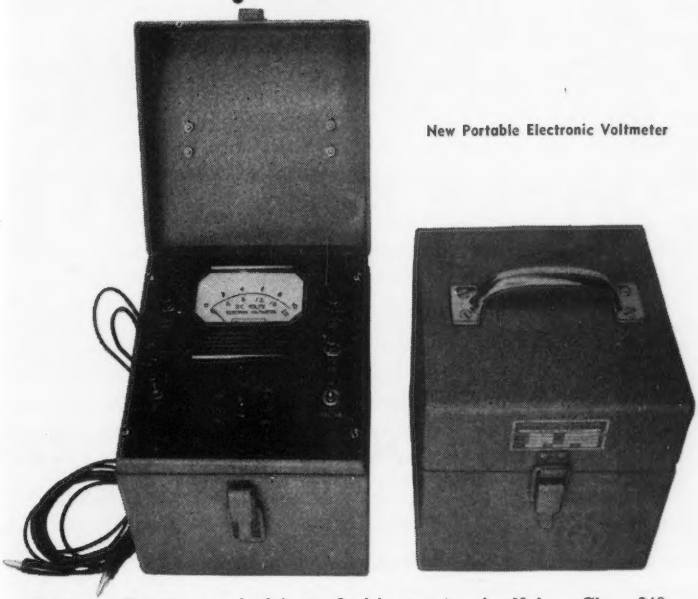

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sures and temperatures. For satisfactory operations, enough water has to be provided to saturate the gas entering the tube, yet retain the injected sodium chromate in solution. 16 references.—INCO.

Progress in Metals. Sucker Rods for Corrosion Fatigue. W. L. NELSON, Oil & Gas J., **45**, No. 38, 283 (1947) Jan. 25.

Composition and properties, including corrosion fatigue endurance to air, salt water and H_2S, are tabulated for a nickel-copper steel (Reliance) and a nickel-molybdenum steel (Type 5) used for heavy duty sucker rods for corrosive wells by the Emsco Derrick & Equipment Co. Type 5 is recommended for corrosive conditions, but severe corrosion calls for the 1½ copper "Reliance" steel. Both rods are heat treated full length and the copper-nickel steel is precipitation hardened at a low temperature to avoid warping and scaling. Carbon content is kept low (0.07-0.13) to assist in corrosion resistance.—INCO.

Coated Drill Pipe Successful in Permian Basin. G. WEBER, Oil & Gas J., **45**, No. 39, 40-41 (1947) Feb. 1.

As a result of its success in the most troublesome major drilling area in the U. S., plastic-coated drill pipe emerges as a partial, but practical solution to the major problem of drill-pipe failures in highly corrosive areas. Early experimental work and history and results of field testing are described, with illustrations.—INCO.

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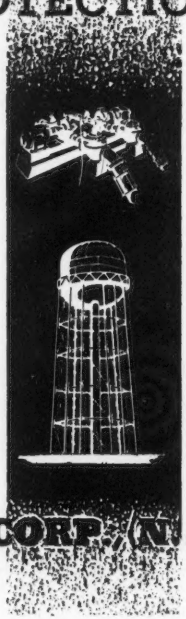

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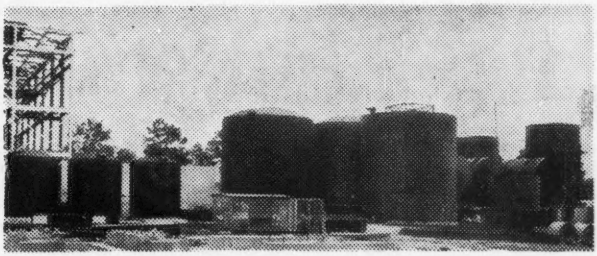

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Note on the Quantitative Implications of Hanawalt's Theory of Corrosion of Magnesium-Base Alloys. C. J. BUSHROD, J. Inst. of Metals (Eng.), 567-572 (1947) May.

The theory, postulated by Hanawalt, Nelson and Peloubet, to account for the influence of traces of iron and other impurities on the corrosion of magnesium-base alloys is developed on a quantitative basis. The resulting equation is shown to agree with experimental results previously obtained, using two alloys of differing iron content. It is suggested that the equation should be fitted to results obtained from alloys in which the impurities were subject to closer control but, in addition, prior reasons are given for supposing that the basis theory is incorrect. (Author's summary.)—ALL.

GENERAL CORROSION

Glossary of Corrosion Terms. Chem. Industries, **60,** 618-620 (1947) Apr.

Glossary was prepared for inclusion in the forthcoming Corrosion Handbook, sponsored by the Electrochemical Society and to be published by John Wiley & Sons.—BLR.

Is Corrosion Taking Dollars from Your Pockets? B. J. COTEY, Turco Products, Inc., Oil & Gas J. **46,** No. 1:68, 71, 92-3, (1947) May 10.

Describes a new chemical anticorrosive treatment, field tests of which indicate that "1 pt. per day" reduced the number of pulling jobs

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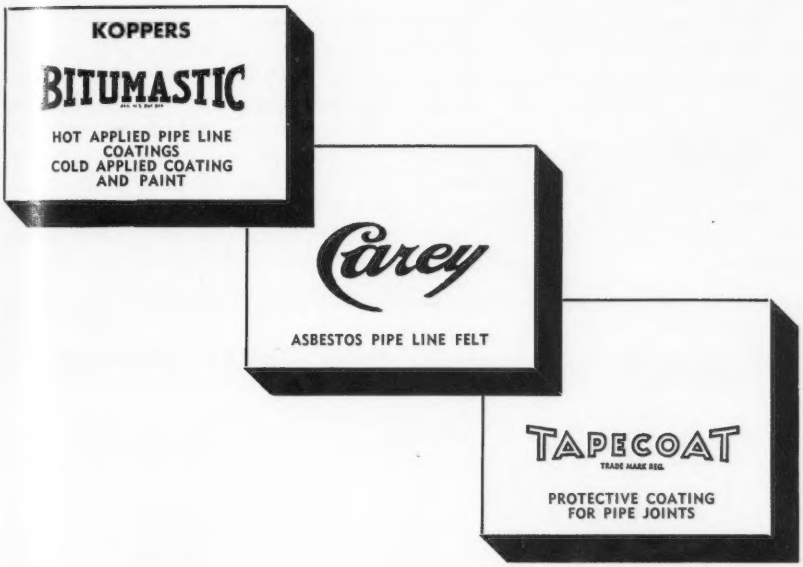

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due to corrosion. Case histories of three California wells using this chemical treatment are given, and manner of application described. Neither the composition of the chemical nor the name of the company are given.

INHIBITORS

New Corrosion Inhibitors for Oil and Gas Well Equipment. Chem. Eng. **54,** No. 5, 190 (1947) May.

New corrosion inhibitors, known as the "Kontol" line, are announced by the Tretolite Co., St. Louis, for treating both pumping and condensate equipment. Kontol 115 is an oil soluble liquid, surface active, which builds up a thin film on the metal surface and protects it from corrosive elements in either brine or condensate.

METAL FAILURE

Resistance to Cavitation Erosion of Propeller Alloys. R. BEECHING, Translations of the Institution of Engineers & Shipbuilders in Scotland, **90,** 203-245 (1947) Jan.

Gives details of an investigation of the effect of composition upon resistance to cavitation erosion for several series of alloys. The composition ranges examined embraced all the more satisfactory types of alloy which have been used for propellers up to the present. Results are tabulated, charted, and discussed. Several ways of producing propeller alloys with combinations of mechanical properties superior to manganese bronze or aluminum bronze were revealed.—BLR.

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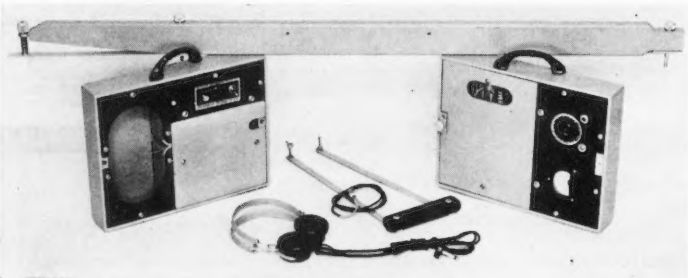

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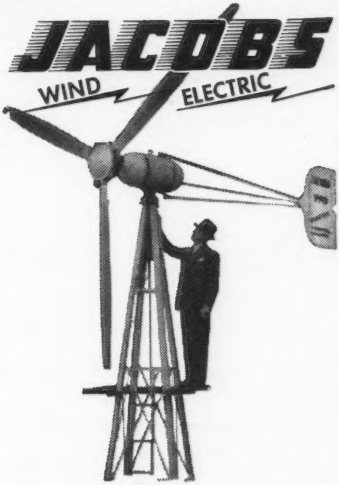

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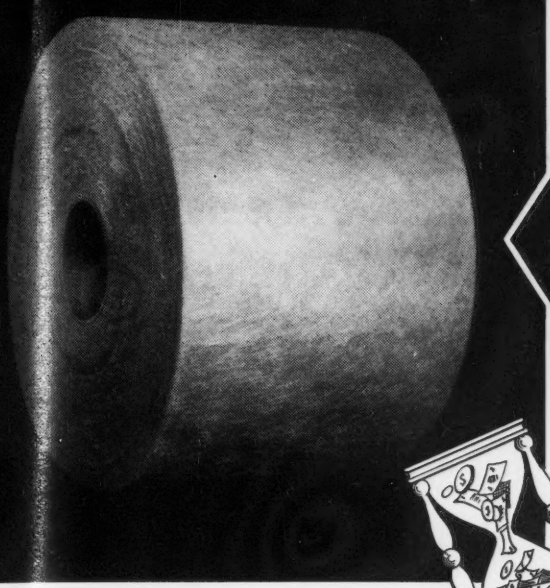

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1. ***Perrault Glass Pipe Wrap is non-corrosive and has no contact-reaction with metal.**
2. **The glass filaments in *Perrault Glass Pipe Wrap cannot absorb moisture.**
3. ***Perrault Glass Pipe Wrap resists organic solvents and acids in soil.**
4. **Changes in temperature encountered in application and use have no effect on *Perrault Glass Pipe Wrap.**
5. **Excellent tensile strength plus extremely light weight provide for quick and easy application.**
6. ***Perrault Glass Pipe Wrap has a natural initial absorbency which allows it to pick up more coating than other materials of the same thickness and helps eliminate "holidays."**

**Manufactured and Engineered by the Glasfloss Corporation for distribution by Perrault Brothers.*

PERRAULT Brothers INC.

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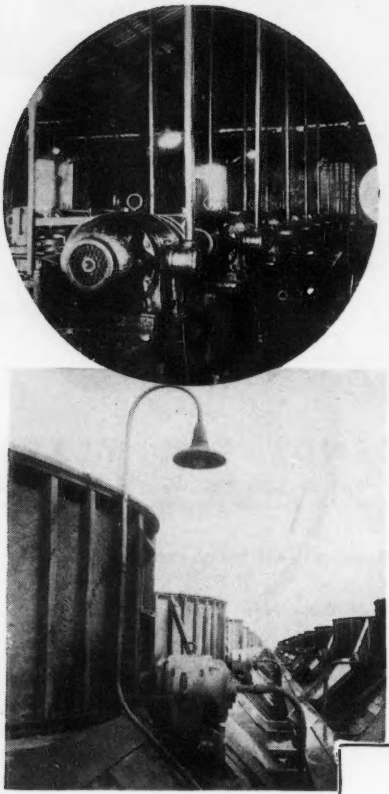
10 YEARS OF EXPOSURE

...and EVERDUR Conduit sets notable service record in Port Arthur refinery



"At the Port Arthur, Texas Plant of The Texas Company, Everdur Conduit is used for protecting motor circuits from corrosive vapors in the Acid Centrifuge Building. Also in lighting systems on No. 2 Alkylation Unit Cooling Tower and FCCU Cooling Tower."

INSTALLED IN 1937 in the Acid Centrifuge Building of The Texas Company's Port Arthur, Texas Plant, Everdur* Electrical Conduit shows no evidence of deterioration—despite constant exposure to corrosive vapors. Other installations of Everdur Conduit at this plant resist the attack of moist salt air in outdoor locations.

Everdur Copper-Silicon Alloys are characterized by high strength and excellent resistance to corrosion. Installations made since 1933 have shown time and again that where ordinary conduit fails in months, Everdur Conduit lasts for years. It is available in two wall thicknesses, rigid conduit (RC) in nominal sizes ¼" to 4" inclusive, and the thinner walled Electrical Metallic Tubing (EMT) in nominal sizes ⅜" to 2" inclusive. Complete lines of fittings... connectors, couplings, outlet boxes, etc. ...are available in Everdur Alloys from leading manufacturers.

*Reg. U. S. Pat. Off.

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Special design machinery for cleaning—priming—coating—and—wrapping all standard sizes of pipe from ¾" nominal, to 30" O. D., assures positive control in each step of application.

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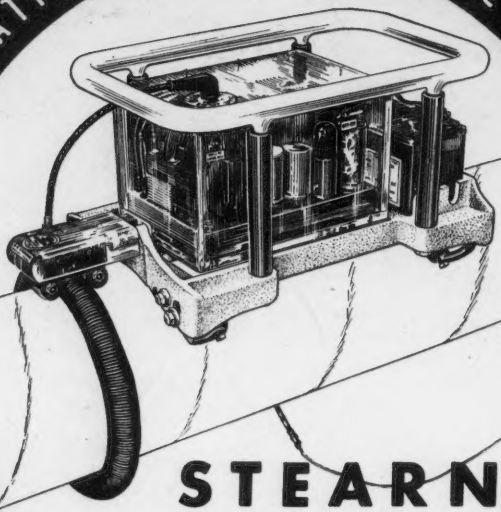

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